COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

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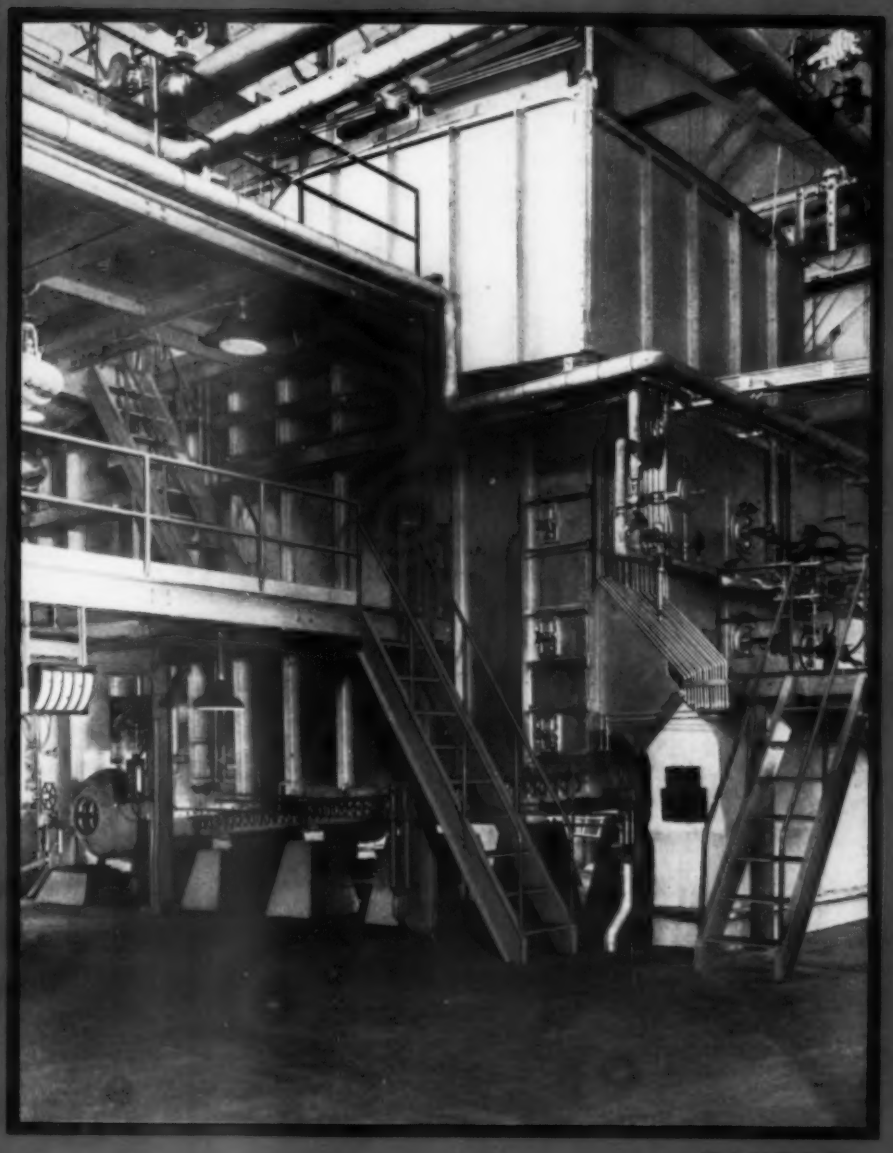
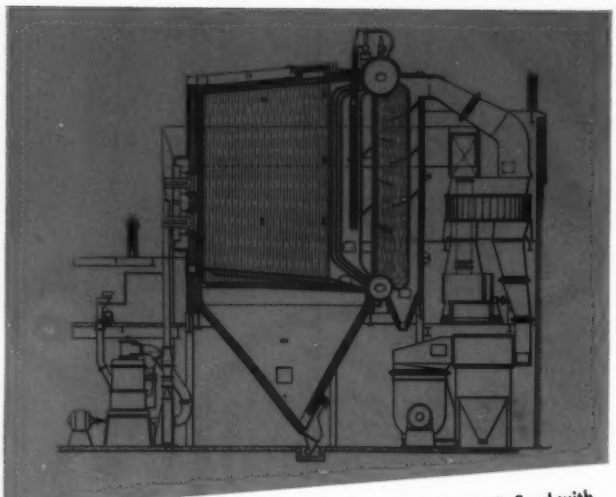


Photo by H. R. Tanee

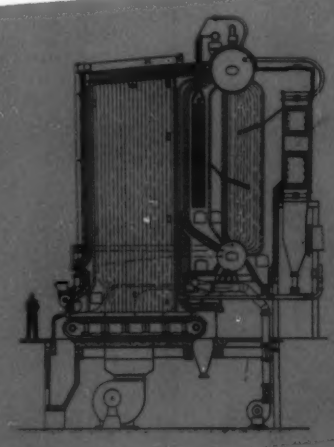
Oil-fired boiler in Anheuser-Busch's new brewery at Newark, N. J.

Power for Norwich State Hospital ▸

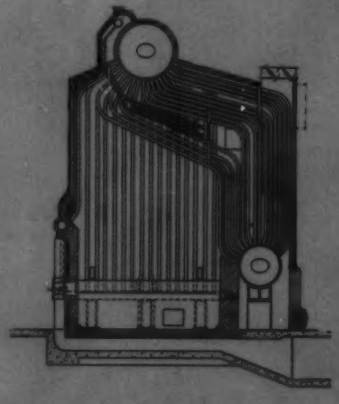
Electric Power for New York's Transportation System ▸



VU installation in a TEXTILE PLANT. This unit is fired with pulverized coal. Capacity—150,000 lb of steam per hour; operating pressure—600 psi; steam temperature—700 F.



VU installation in a TOBACCO PLANT. This unit is fired by a C-E Spreader Stoker (continuous discharge type). Capacity—80,000 lb of steam per hr; operating pressure —425 psi; steam temperature—650 F



VU installation in an AUTOMOTIVE PLANT. This unit is fired with oil. Capacity—40,000 lb of steam per hour; operating pressure—150 psi. There is no superheat.

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* * *

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Vol. 23 **No. 8**

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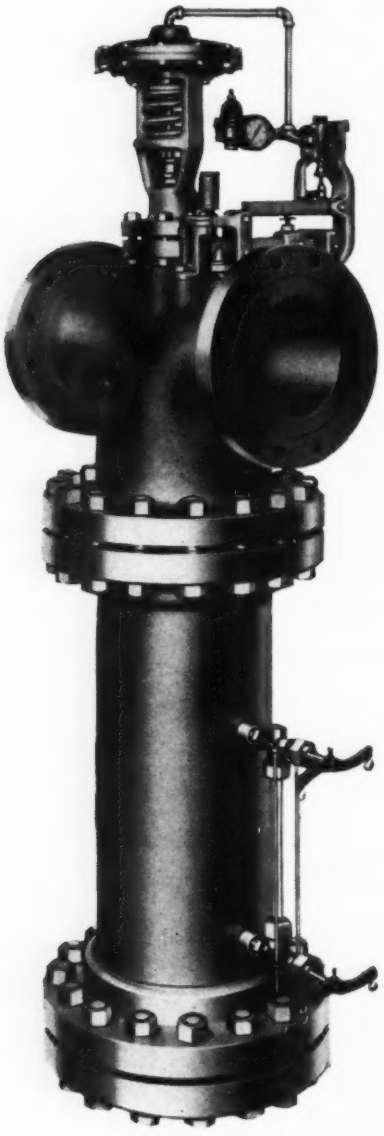

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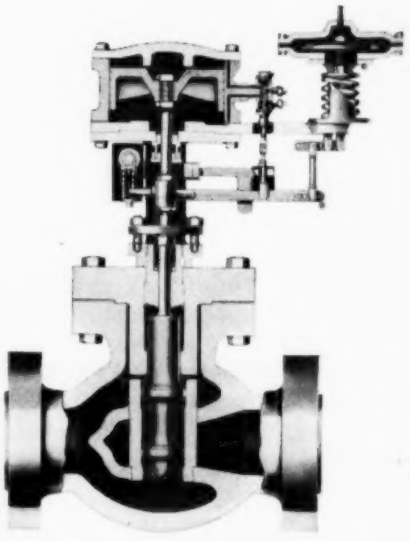

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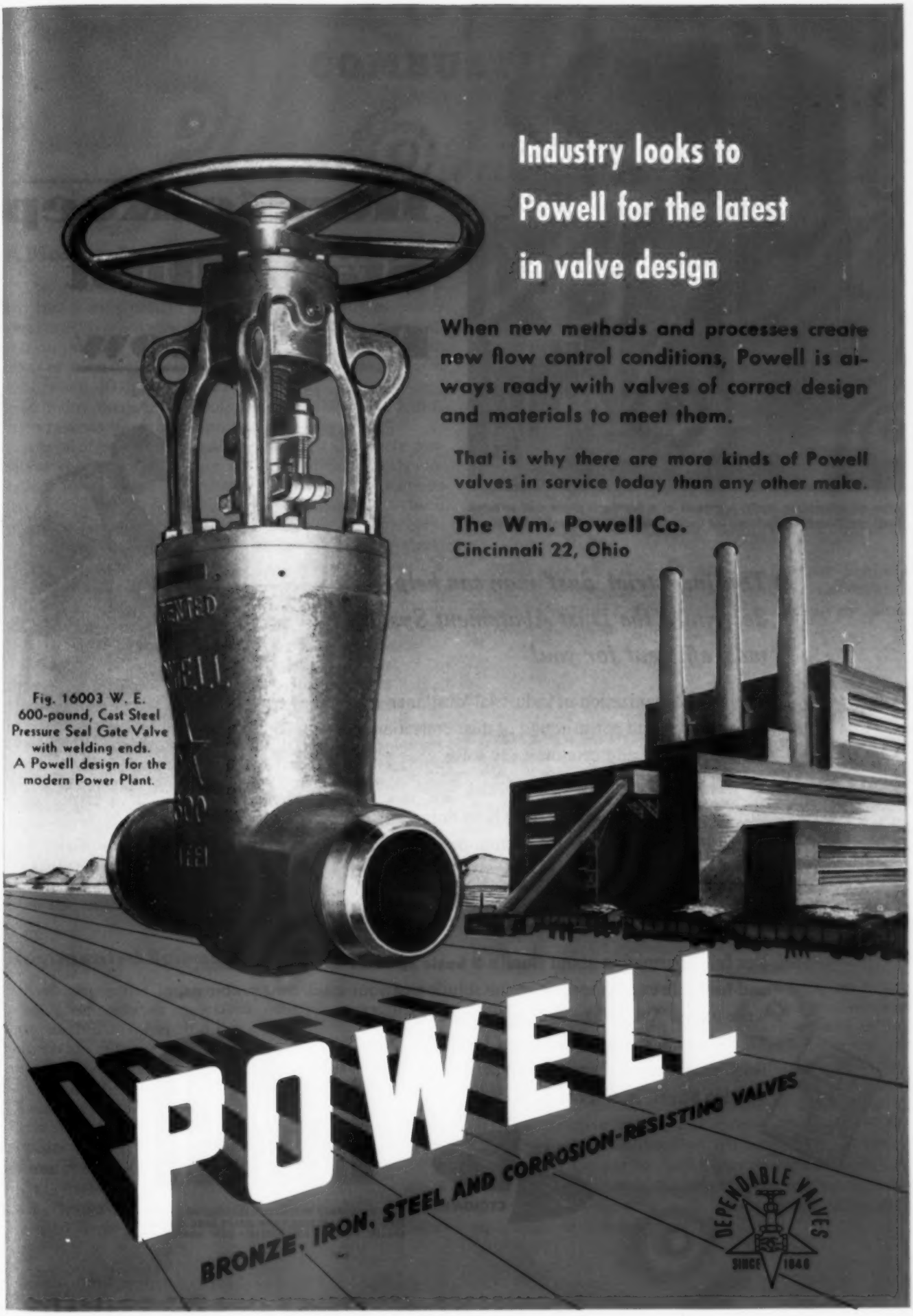
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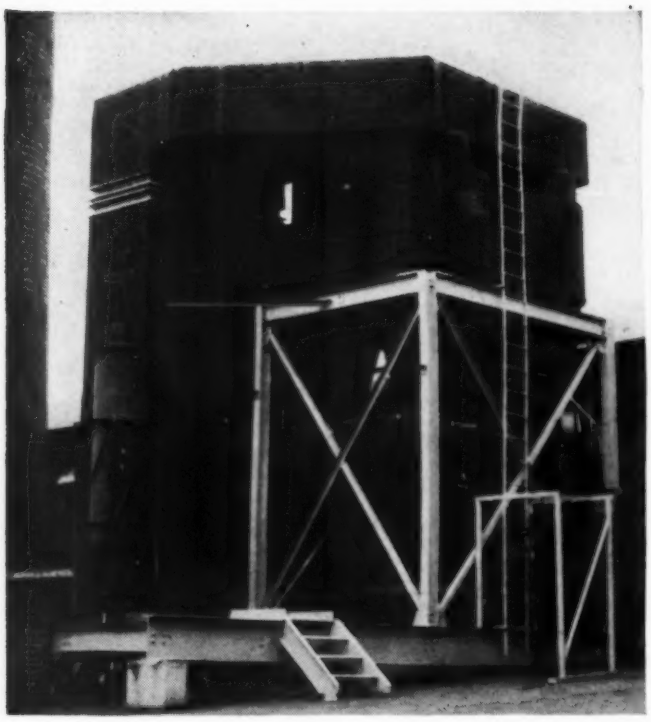

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Editorials

A Modern Institutional Power Plant

The term "high pressure" in the steam power industry has had a wide variety of meanings as the art of power generation has advanced. In considering current central station practice high pressure might refer to 1200, 1500, 2000 or even 2400-psig installations. But there was a time when 400 psig was considered high pressure, and even today there are some segments of the power industry where its use is something of a novelty.

A type of power user that has remained extremely conservative as regards higher steam conditions is the so-called institutional power plant. Many institutions having combined power and heating loads have been reluctant to scrap existing steam engines and low-pressure boilers. Even where turbines have replaced engines, steam conditions ranging from 150 to 250 psig with a few degrees of superheat have been the general practice. Automatic controls and other refinements usually found in industrial power plants and central stations have been slow to find acceptance in institutional installations.

With this background in mind the new power plant of the Norwich State Hospital, described in this issue, stands out as a good example of advanced practice in the institutional field. Designed to operate on a 400-psig cycle with steam superheated to 645 F, this isolated plant has both motor- and turbine-driven auxiliaries and a high degree of centralized control. A much better plant heat balance has been obtained through the use of these higher steam conditions, and considerable savings in fuel expenditure are anticipated. It stands to reason that other institutions contemplating a program of expansion or modernization of power facilities could profit from the example set at Norwich.

Regimented Scientific Thinking

Aside from the familiar fabulous claims of Russian accomplishments as associated with propaganda, very little authentic information of a scientific or engineering nature has filtered through the Iron Curtain in recent years. Therefore, it is of interest to note the translation of a report of the Commission of the Institute of Organic Chemistry of the Academy of Sciences, USSR, on "The Present State of the Chemical Structural Theory" which appears in the January, 1952, issue of the *Journal of Chemical Education* (USA).

It is irrelevant here to cite or discuss this theory which was advanced more than fifty years ago by a Russian scientist named Butlerv, but it is believed that readers may be interested in the following quotation from this recent report:

"The decisions of the Central Committee of VKP in regard to ideological problems and the sessions of the VASKhNIL have mobilized Soviet scientists for the solution of the problem of a critical analysis of the present state of theoretical concepts in all fields of knowledge and the struggle against the alien reactionary ideas of bourgeois science.

"The crisis of bourgeois science (connected with the general crisis of the capitalistic system) has manifested itself in the theoretical concepts of organic chemistry now being developed by bourgeois scientists. These have led to the appearance of methodologically faulty concepts which are slowing down further scientific development."

The above quotation reveals how Marxian-Leninist ideology and regimentation are dominating Russian scientific thinking. This, from the American viewpoint, is almost certain to stifle progress.

From One to Many

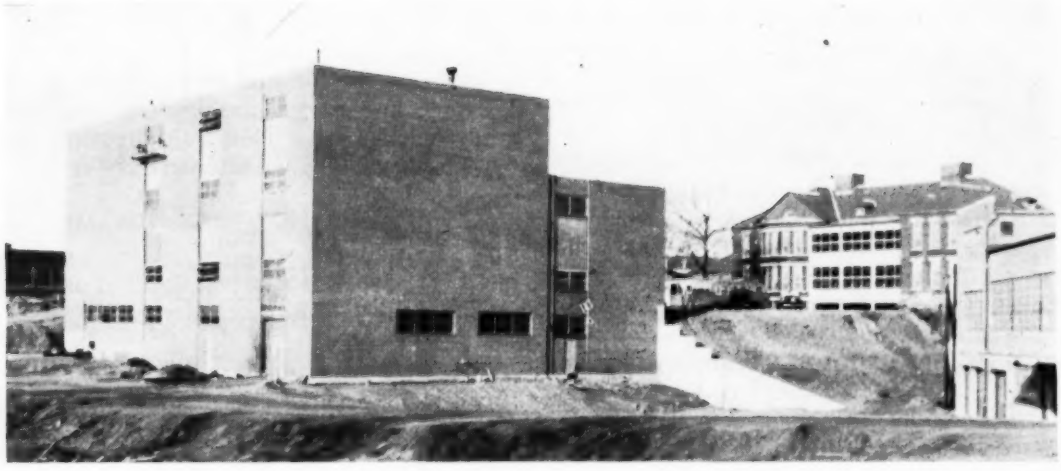
In these days of 200,000-kw single boiler-turbine-generator units under construction it may be something of a surprise to note that the Kaiser Aluminum and Chemical Corporation is installing a total of eighty gas-burning radial engines and direct-connected d-c generators at its new alumina reduction plant near New Orleans, La. There is a curious similarity between the interior appearance and arrangements of these new installations and that of the steam engines which have served the New York City transit system since the early 1900's, photos of both of which are shown in this issue.

At the same Kaiser defense plant, in addition to the two 40-engine installations, there is to be a semi-outdoor steam plant made up of 15 steam generators and 16 turbine-generators. Each of the buildings housing the gas engines is 480 ft in length, while that for the steam turbines is to have a length of 750 ft. In the absence of more detailed information it would be interesting to learn the relative capital and maintenance costs of the two types of installation and the number of operating personnel. A question might also be raised concerning the underlying reasons for selecting such a multiplicity of internal-combustion and steam-driven generating equipment for a single plant.

Power for Norwich State Hospital

By STUART W. ALLEN* and JOHN W. CLARKE†

Compared to most institutional power plants which employ steam at 250 psig or below with little or no superheat, this installation generates steam at 400 psig, 645 F in three 35,000-lb per hr standardized boilers. Two 1000-kw turbine-generators are installed and one complete set of auxiliary equipment is turbine-driven. Engineering considerations in studying load conditions and for safeguarding this isolated plant are presented.



Exterior view of power plant

RELIABILITY and dependability were important keynotes in the design of the new power plant for the Norwich State Hospital, located along the easterly bank of the Thames River about three miles from Norwich and twelve miles from New London, Connecticut. This plant has no electrical connections with other power systems, and therefore greater precautions were taken against possibilities of forced outage than is usually the case in an installation of its size.

The Norwich State Hospital is a major psychiatric hospital operated by the State of Connecticut and has more than 3000 patients in residence at the present time. Operating with a staff of nearly 800 persons, the institution also conducts a teaching program for student nurses, theological interns, psychology interns and occupational therapy students (University of Connecticut) and graduate teaching for professional nurses and medical doctors.

Started in 1904, the institution now occupies approximately 745 acres and comprises some 75 buildings. Throughout its history the hospital administration has been conscious of the importance of the power plant. All of the steam mains and electrical cables are carried in underground tunnels and conduits from a central plant in which about 25 years ago water-tube boilers had replaced the original hrt boilers.

Use of steam in the hospital covers the entire range of modern living. A good proportion of the food is cooked in steam kettles and pressure steamers. A new laundry capable of processing 100,000 lb of soiled linen in a five-day, forty-hour work week must also be supplied with steam and hot water. In all of the buildings hot

* Mechanical Engineer, New Haven, Conn.
† Business Manager, Norwich State Hospital.

water is heated by steam, a circulating line from a central point being used for some buildings and independent storage heaters for the others. Sterilizing is carried out in three different places with 30-psig steam.

Design Considerations

The administrative group operating the hospital felt that if high-pressure, high-temperature steam with its attained effectiveness was good for industry, it would also be good for a state institution. Consequently, the designing engineers, Newman E. Argraves & Associates of New Haven, were asked to study the situation thoroughly in an effort to produce the most efficient plant that could be economically justified for the load involved. The result is a plant which, though not radical in design, incorporates some of the more advanced features of central station practice. It is expected to show substantial savings in fuel cost and provide an example of economies that institutions may realize from the use of higher steam conditions and heat recovery equipment.

Existing Plant

The existing plant, located some distance from the new plant, consists of four 4-drum boilers set in batteries of two and fired by underfeed stokers. Total steam generating capacity is 62,000 lb per hr. There are two non-condensing turbine-generators supplied with steam at 140 psig, one of which has an extraction stage at 40 psig and both of which exhaust to 3-psig mains. They have a combined nameplate rating of 1125 kw.

Not only is much of the equipment in the existing plant obsolete, but there is also the problem that a considerable quantity of steam must be exhausted to atmosphere when generating the required power during mild weather. The decision to construct a new plant was also influenced by the prospect of an increasing electrical load without a more than corresponding addition in steam requirements. The existing plant will be dismantled sometime after the new installation goes into service in the summer of 1952.

Engineering Studies

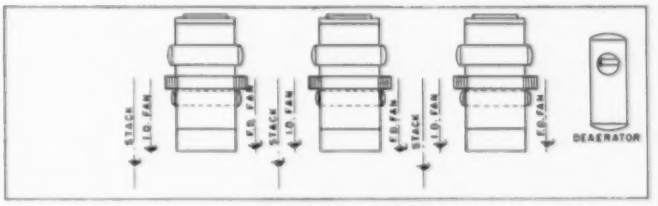
Present average steam usage for the summer months is on the order of 27,000 lb per hr, and during the winter it rises to 46,000 lb per hr with a peak hourly load of 55,000 lb. Electrical load ranges from 250 kw in the summer to 400 kw in the winter, with a peak of approximately 625 kw. Peaks for both steam and electricity are generally reached late in the morning, the heavy laundry and kitchen loads contributing to these peaks.

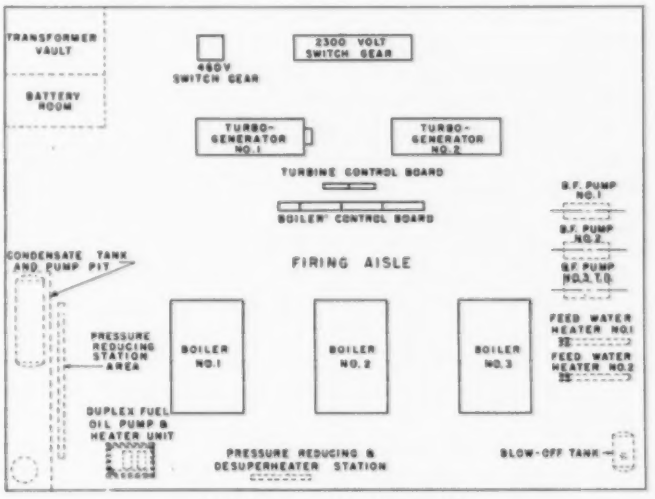
There are other factors to be taken into consideration. The new power plant is the first step in a ten-year building program, projected parts of which include a 300-bed admissions building, an occupational therapy building, an apartment house for staff members, and a stores building.

Changing conceptions of psychiatric treatment also have had a marked effect upon the steam and electric load. Formerly, institutions of this sort were looked upon as custodial centers in which patients were put to bed immediately after the evening meal. Now the philosophy has changed, and patients are allowed to stay up to 9 or 10 p.m. and are kept occupied in recreational or occupational therapy programs. This extends the period of relatively heavy power and steam loads by several hours.

Another factor affecting the steam load is the changing character of the hospital population. In recent years the percentage of aged patients has greatly increased. Heating levels in sections of the hospital occupied by these patients have been increased because of their greater susceptibility to pneumonia.

All of these factors were taken into consideration in the engineering studies. Power generation is a by-product of an essential steam and process-heating load, and the ratio of power load to steam load is a fundamental consideration. Because of the increasing demands for electricity and the use of more efficient heat-transfer equipment, the power load is being built up faster than the heat load. To meet this condition it became necessary to take advantage of higher steam pressures and





Plan view showing layout of principal equipment on operating floor, basement and mezzanine

temperatures in order to generate more by-product power per pound of steam.

Studies were made to determine the economy of 250- and 350-psig condensing and noncondensing turbines. Heat balance calculations showed that the most economical arrangement was to employ turbine throttle conditions of 350 psig, 645 F with an extraction point at 30 psig and back-pressure exhaust of 5 psig. Three reducing and desuperheating stations were incorporated in the cycle to provide necessary flexibility and to aid in taking care of the peak winter heating load.

Additional studies were made of the comparative operating costs of 625-kw and 1000-kw turbine-generators, assuming that three of the smaller units or two of the larger would be installed. It was found that for the given load conditions the 1000-kw units would

require nearly 10 per cent less steam than the smaller machines.

With regard to electrical load, records at the hospital showed that it had increased 31 per cent over a span of five years beginning in 1944. Studies of the characteristics of this load were made, and consideration was given to the additional power required for the buildings to be constructed under the ten-year expansion program mentioned earlier. Twenty per cent was added to the total of the existing and the projected loads and the combined total was used as a basis for sizing the generators and making changes in the electrical distribution system.

Steam Generating Equipment

Steam is supplied by three Combustion Engineering Type VU-10 two-drum water-tube boilers which are equipped with superheaters, water walls and steel-enclosed casings. Design pressure is 475 psig and steam is generated at 400 psig. Temperature at the superheater outlet is 645 F. Each boiler has a maximum continuous rating of 35,000 lb of steam per hour and a two-hour peak of 42,000 lb per hr.

Firing is by means of Peabody steam-atomizing oil burners, each boiler being equipped with three burners. It is planned to burn Bunker C (No. 6) fuel oil having a heat content of 18,300 Btu per lb. The plant is designed so that in the event of changing conditions of oil supply, or for other justifiable reasons, spreader stokers may be installed. The physical size of the plant itself is sufficient to accommodate overhead coal bunkers, ash hoppers, dust collectors, and coal- and ash-handling equipment.

Heat recovery equipment for each unit comprises a three-pass tubular air preheater having a heating surface of 1410 sq. ft. Recirculation control is provided to protect against corrosion should the temperature of the gases leaving the air heater drop below 300 F.

The boilers, including air heaters, are designed for an efficiency of 84 per cent at maximum continuous rating.

Two of the boilers have motor-driven auxiliaries and the third employs steam turbines exhausting to 5-psig lines.

Both the forced- and induced-draft fans are of Westinghouse-Sturtevant manufacture. The single-width, single-inlet forced-draft fans have down-blast discharge and are capable of delivering 12,750 cfm at a static pressure of 7.65 in. when driven at 1760 rpm. The induced-draft fans are of double-width, double-inlet design with upblast discharge and are capable of delivering 23,100 cfm at 3.85 in. static pressure and 460 F when driven at 1160 rpm. Control of the forced-draft fans is by inlet vanes, while the induced-draft fans are controlled by means of outlet dampers.

There are three self-supporting steel stacks extending 50 ft above the roof and equipped with inside ladders and painters' trolleys at the top.

Fuel Oil Storage and Fuel Oil Handling System

No. 6 fuel oil will be stored in two steel tanks located adjacent to the New York, New Haven and Hartford Railroad and not far from the Thames River. A small catwalk and dock are to be built on the bank of the river to accommodate small oil tankers. The combined capacity of the two tanks will be 1,400,000 gal, which will supply fuel requirements for approximately two-thirds of a year. The necessary fuel-handling pumps will be located in a small brick pump house located between the two tanks, adjacent to facilities for unloading tank cars and for pumping from tankers. Tanks for day storage of fuel oil are located adjacent to the power plant.

Combustion Control

The combustion control system is designed to proportion fuel and air in proper relation to steam load demand and to divide the load suitably between the boilers that are in service. It is also intended to prevent unnecessary fluctuation in steam pressure and feedwater level. Provision is made to measure steam flow, air flow and boiler water level. Air is the operating medium for the combustion control system, which is of Bailey Meter design.

Each boiler panel has meters to indicate and record steam flow and air flow as well as to record steam temperature, flue gas temperatures and air temperature leaving the air heater. Feedwater flow meters, drum-level recorders of the mercury U-tube type, and six-point draft gages are also provided for each boiler.

Making up the combustion control systems are master pressure controllers, vane and damper operating mechanisms for the forced- and induced-draft fans, fuel oil control valves, furnace draft controllers, and steam flow-air flow controllers. Automatic shut-off valves are provided in the fuel oil line to shut off the supply in the event of fan failure or loss of fuel-oil or steam-atomizing pressure. An adjustable time delay relay is installed as a purge interlock so that the induced-draft fan may remove all combustible gases from the furnace before restoring fuel supply.

Turbine Generators

Two Worthington 1000-kw steam turbines are installed, operating at throttle conditions of 350 psig, 645 F. Controlled extraction from the main turbine is at 30 psig and exhaust is at 5 psig. Electric Machinery generators are direct connected to the turbines through double helical reducing gears. The turbines operate at 5700 rpm and the generators at 1200 rpm. The latter are of the revolving field type, with direct-connected exciters.

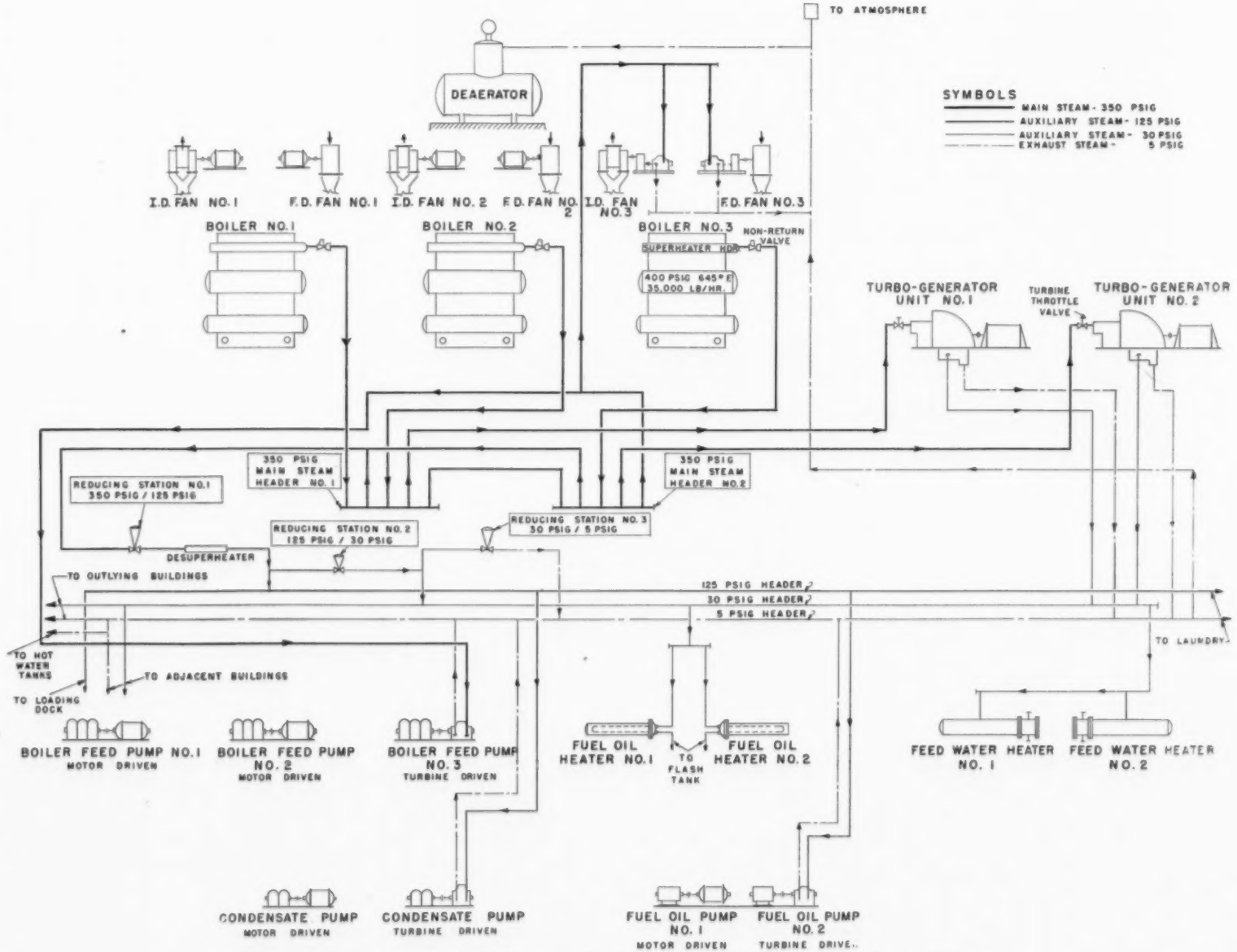
TOTAL STEAM FLOW TO THROTTLE (LB PER KWHR)

Operating Conditions	Load, Kw, at 80% Power Factor		
Throttle pressure: 350 psig, 645 F Extracting at 30 psig	500	750	1000
Back pressure 5 psig with Zero extraction	25.4	22.4	21.4
Extracting 8000 lb per hr	29.8	25.5	24.4

The generators are rated at 1000 kw at 80 per cent power factor, 1250 kva, three phase, 60 cycle, 2400 volts, and the turbines have sufficient capacity to drive the generators continuously when delivering 1250 kva at unity power factor. Controls are provided to operate them singly or in parallel.

Feedwater System

Three boiler feed pumps are installed, two of which are motor-driven and the third, turbine-driven. Pro-


TO ATMOSPHERE
DEAERATOR
SYMBOLS
MAIN STEAM - 350 PSIG
AUXILIARY STEAM - 125 PSIG
AUXILIARY STEAM - 30 PSIG
EXHAUST STEAM - 5 PSIG
I.D. FAN NO. 1
F.D. FAN NO. 1
I.D. FAN NO. 2
F.D. FAN NO. 2
I.D. FAN NO. 3
F.D. FAN NO. 3
BOILER NO. 1
BOILER NO. 2
BOILER NO. 3
SUPERHEATER HDR.
NON-RETURN VALVE
400 PSIG 645°F 35,000 LB/HR.
TURBO-GENERATOR UNIT NO. 1
TURBINE THROTTLE VALVE
TURBO-GENERATOR UNIT NO. 2
350 PSIG MAIN STEAM HEADER NO. 1
350 PSIG MAIN STEAM HEADER NO. 2
REDUCING STATION NO. 1 350 PSIG / 125 PSIG
REDUCING STATION NO. 2 125 PSIG / 30 PSIG
REDUCING STATION NO. 3 30 PSIG / 5 PSIG
DESUPERHEATER
TO OUTLYING BUILDINGS
125 PSIG HEADER
30 PSIG HEADER
5 PSIG HEADER
TO LAUNDRY
TO HOT WATER TANKS
TO ADJACENT BUILDINGS
TO LOADING DOCK
BOILER FEED PUMP NO. 1 MOTOR DRIVEN
BOILER FEED PUMP NO. 2 MOTOR DRIVEN
BOILER FEED PUMP NO. 3 TURBINE DRIVEN
FUEL OIL HEATER NO. 1
TO FLASH TANK
FUEL OIL HEATER NO. 2
FEED WATER HEATER NO. 1
FEED WATER HEATER NO. 2
CONDENSATE PUMP MOTOR DRIVEN
CONDENSATE PUMP TURBINE DRIVEN
FUEL OIL PUMP NO. 1 MOTOR DRIVEN
FUEL OIL PUMP NO. 2 TURBINE DRIVE..

Schematic flow diagram, including auxiliary equipment and steam distribution system

vision is made for the turbine-driven pump to cut in automatically in case of power failure or drop in pump discharge pressure. The Worthington pumps are of the four-stage, horizontal split-casing type and have a capacity of 125 gpm against a total dynamic head of 1200 ft. All are driven at 3500 rpm. The feedwater regulators are of Bailey Meter three-element design.

Closed feedwater heaters supplied by Davis Engineering Corp. are installed in duplicate and are of the horizontal U-tube type with removable tube bundles. They are operated on 30-psig extraction steam and are intended to raise the feedwater temperature from 227 to 260 F.

The deaerating heater is of Worthington design and is capable of delivering 80,000 lb per hr of boiler feed, of which 20 per cent is makeup water at 50 F and 80 per cent, condensate returns at 180 F. It is equipped with a vent condenser and float controls.

There are two condensate pumps, one motor and the other turbine-driven, which have a capacity of 125 gpm under a dynamic head of 180 ft.

The continuous blowdown system incorporates heat-reclaiming equipment.

Reducing Stations

To aid in flexibility of operation the plant has been supplied with three reducing stations. The largest of these incorporates a desuperheater and reduces steam from 350 to 125 psig. At this pressure steam is used to drive turbines for the condensate and fuel oil pumps, in the laundry and for the steam-atomizing oil burners. Also, 125-psig steam is used for pumping fuel oil from barges or tankers. This station is of Bailey Meter design and has a capacity of 42,000 lb of steam per hour.

A second reducing station cuts the pressure down to 30 psig. This steam is used for heating and furnishing hot water for the outer group of buildings of the institution, and for the fuel oil and closed feedwater heaters. Steam from this reducing station supplements 30 psig steam extracted from the power turbines.

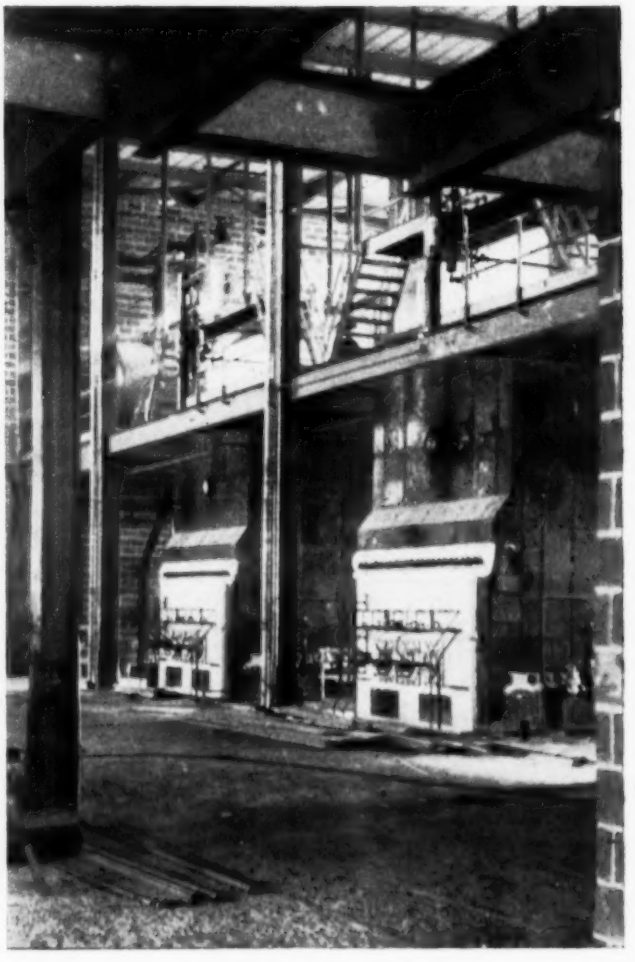
At a third station steam pressure is reduced from 30 to 5 psig. It is discharged into the same header as the exhaust from the power and station-auxiliary turbines. The primary use for 5-psig steam is for building heating and furnishing hot water to the laundry and the inner circle of buildings. The deaerator is also supplied with steam at this pressure, some of which may come from the exhaust of the turbine-driven auxiliaries. The second and third stations are supplied by the Fisher Governor Company.

Switchgear

The switchgear is of Westinghouse design and consists of one ten-unit, 2400-volt metal-clad switchboard and one three-unit, 460-volt metal-clad switchboard. The 2400-volt switchgear provides switching and interrupting apparatus for the outlying transformer stations and for the two generators. The 460-volt switchgear is used in connection with the power plant auxiliaries which may be controlled either from the main switchboard or at the locations of their respective motors.

Frequency Control

An important consideration in the design of an isolated power station is frequency control for maintaining the accuracy of synchronous clocks. Western Union time service is available through the hospital telephone exchange. The speed of the turbine-generators may be adjusted through the turbine-governor synchronizing motors by means of a manually operated governor switch on the generator switchboard. By operating this governor switch at occasional intervals, the hospital clocks may be brought to conformity with the outside standard.



Construction view showing two of the boilers with deaerating heater in upper background

Design and Construction

Newman E. Argraves & Associates of New Haven served as designing and consulting engineers. Acting as general contractors for the project was the F. H. McGraw Company of Hartford.

Acknowledgment

The authors wish to express their appreciation to Dr. Ronald H. Kettle, Superintendent of Norwich State Hospital, to Mrs. G. Gardiner Russell, Chairman of the Board of Trustees, and to Mr. Philip A. Johnson, Chairman of the Building Committee, for their cooperation and for granting permission to publish this article.

Attainment of Full Power Program Doubted by Advisory Committee

IN A report to the Defense Production Administration the Electric Power Advisory Committee, under the chairmanship of E. W. Morehouse, advocates a careful re-examination of the present power program covering the next three years. This is on the grounds that the peak estimates, based upon earlier studies by DEPA in collaboration with the electric utilities, could not foresee some new significant defense developments involving heavy power requirements nor certain others likely to materialize; hence, the estimates are considered as too low and geographical shortages in supply are indicated.

These estimates of peak demands on the utilities and capabilities for the country as a whole were as follows:

	Peak Demands	Capabilities
1952	77,840,000 kw	84,460,000 kw
1953	85,220,000 kw	96,680,000 kw
1954	90,800,000 kw	105,080,000 kw

The Committee feels that while the 1952 estimate may represent a fairly realistic forecast of demand, those for 1953 and 1954 are on the low side in the face of a sustained defense program coupled with relatively high civilian use of electricity. This leads to the belief that load estimates for 1953 should be increased by as much as two million kilowatts and the 1954 estimates by four or five million.

Although new units scheduled for delivery in 1952 and 1953 reflect orders which virtually book to the limit the manufacturing facilities of heavy power equipment producers, those for 1954 would not take up the full manufacturing capacities.

The Committee questions whether the capacity planned for installation in 1952 and 1953 can actually be brought into service in those years. Even if this were possible, these figures apply to the whole country and obscure local and regional conditions. The tendency for large defense loads to gravitate to areas between the Great Lakes and the Gulf is likely to render this region one of tight power supply, whereas in the Northeast and the extreme West (excepting the Northwest) there are prospects of an increasing surplus.

Curtailments May Be Necessary

Unless this trend is altered, curtailments in power use in some sections may be unavoidable. It may be possible for defense authorities to steer new large orders into areas where power can most readily be made available, although in some cases this might not be best from an economic or a strategic standpoint. However, little can be done in this respect to change the situation during the present year. There may be some leeway in 1953 and it will be possible to re-examine certain orders scheduled for 1954 and later.

Although the scheduled shipments for 1952 aggregate 10,210,000 kw (nameplate rating), it is now expected that the power capacity that will actually go into service during the present year will be around 9,348,000 kw, of which 7,655,000 kw represents steam and 1,693,000 kw hydro.

The schedule for 1953 calls for shipments of 10,680,000 kw capacity but indications are that a total of 11,034,000 kw is likely to go into service. Of this amount, 9,298,000 kw will be steam and 1,736,000 kw hydro.

Boiler Shipments

The boilers necessary to support the in-service steam capacity referred to above for 1952 have, in part, been shipped and the remainder are expected to be shipped in time to assure the contemplated operation. Those required for turbine capacity expected to be placed in service during 1953 are now scheduled for shipment through 1952 and early 1953.

As for electrical equipment, such as transformers, switch gear, etc. for a program of the magnitude proposed, the committee believes that NPA and DEPA policies now being developed for allottments will avoid such equipment becoming a limiting factor.

With reference to materials, the report observes that one kilowatt of capacity can be fabricated and constructed with $^1/_{100}$ of as much critical materials (including alloy and stainless steels, copper and aluminum) as the same kilowatt can supply the power to produce in one year. In other words, if failure to provide a kilowatt of capacity were to result in a continuous curtailment of a kilowatt of power supply applied to steel, copper or aluminum, the loss in output of these critical materials in one year would be a hundred times as great as the amounts of these materials going into the building of a kilowatt of capacity.

Power shortages causing continuous cutting of load are much less likely, however, than intermittent curtailment resulting from inadequate margins of operating reserves. It is fair to say that a one per cent inadequacy in reserve margin in one year would impose an impairment in production of critical materials five to ten times as great as the amount of materials involved in the building of a power plant of sufficient capacity to prevent such impairment.

It therefore appears to the Committee that an investment in critical materials and other measures to secure an adequate margin of power capacity is a prudent form of insurance.

Furthermore, it is very difficult to catch up with capacity if demand becomes chronically out of balance with supply. When this happens, accumulation of deferred maintenance and the long lead time for new power equipment, as compared with the usual short lead time for new power consuming establishments, tend to create a persistent condition of shortage. Tight or deficit conditions in important regions continuing through 1952, 1953 and 1954 could leave their marks for several years.

Electric Power for New York's Transportation System

This is a high-spot digest of a survey and recommendations made by The J. G. White Engineering Corporation concerning the adequacy of present and future subway power. A history of the three generating plants is included together with proposals for their modernization and expanded capacity. It is noted that five of the 7500-kw engine-driven units installed in 1905, together with their low-pressure turbines, added a few years later, are still in service during peak load periods.

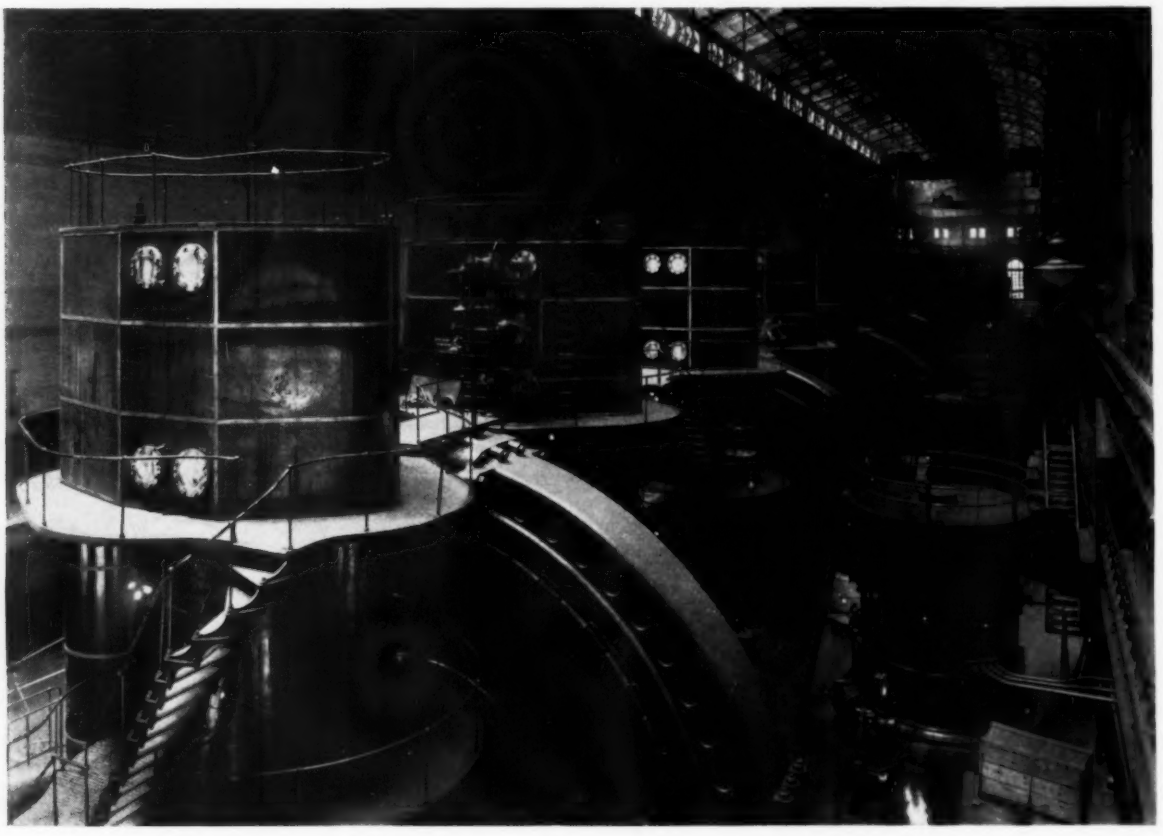
THE importance of adequate and dependable power supply for New York City's subways is measured by the fact that several million persons daily depend upon it for transportation, particularly from home to business and return.

For nearly fifty years the major portion of the power for this transit system has been furnished by three plants—one located on the Hudson River at 59th Street; another at 74th Street and the East River; and the third at Kent Avenue, Brooklyn, and the East River. Power for the so-called Independent Division is purchased from The Consolidated Edison Company.

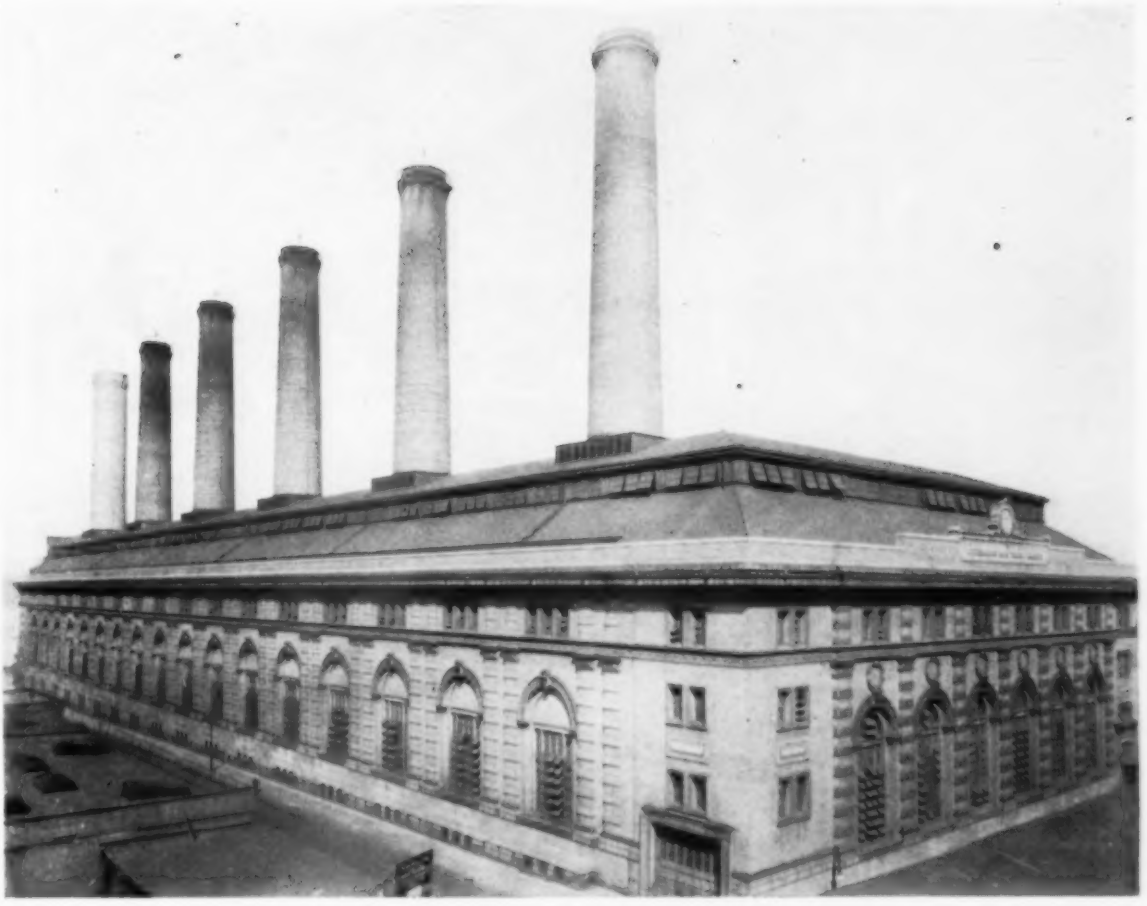
Present power requirement, exclusive of purchased power, totals about 380,000 kw, which is anticipated to increase by 1958 to around 650,000 kw if present transportation plans go through. Of the 380,000 kw about 270,000 kw is capable of being supplied by Fifty-ninth St. and Seventy-fourth St. Stations and 110,000 kw by Kent Ave. Station.

Although certain improvements and limited expansion of the power generating facilities have been made in the intervening years, these plants are far from up to date and capacity is inadequate for the growing load which will be further augmented when the Second Avenue Subway is built and other proposed extensions of the system materialize. Furthermore, not only is the reserve insufficient but the age of much of the equipment raises a serious question as to its continued reliability.

This situation and other considerations led the Board of Transportation, in the summer of 1950, to engage three well-known engineerging firms to make a survey of the whole transit problem. One study, dealing with



Reciprocating engine-generators and their low-pressure turbine-generators in Fifty-ninth Street Station as they appeared in 1917. Five are still in service



Fifty-ninth Street Station before 1951 extension

organization, methods and procedures, was made by Coverdale & Colpitts, in collaboration with Day & Zimmerman, Inc., and another covering power generation, transmission and distribution facilities, together with recommendations, was made by the J. G. White Engineering Corporation. Only the last-mentioned report, which has just been released, will be reviewed here.

Fifty-ninth Street Station

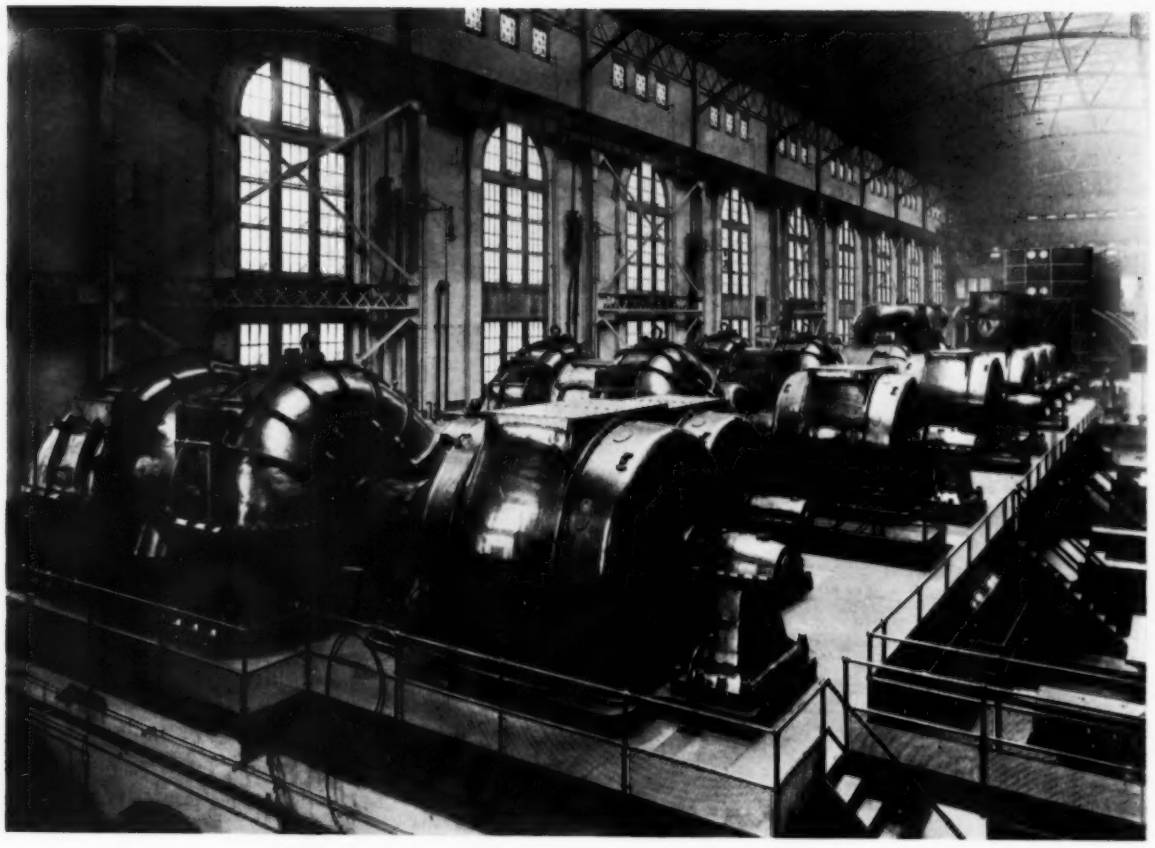
This plant was built in 1904–1905 by the Interborough Rapid Transit Company to serve the original subway lines, first the Lexington and then the Seventh Avenue Subways. The initial installation contained sixty boilers of about 20,000 lb per hr each at 225 psig, which pressure was then considered high. They burned anthracite on hand-fired grates and supplied nine 7500-kw angle-compound engine-driven generating units running at 75 rpm. These had been originally rated at 5000 kw. Designed by the late Edwin Reynolds, widely known engine designer around the beginning of the present century, these units were the largest ever built. They were of the duplex angle-compound type with two 44-in. high-pressure and two 88-in. low-pressure cylinders and a stroke of 60-in. The 25-cycle generator, located between the pairs of cylinders, had a 32-ft rotating field which also served as a flywheel.

Within a short time mechanical stokers of the overfeed type were installed to burn semi-bituminous coal and later, in order to secure increased steam capacity, a second stoker was added under the rear of each of eighteen of the boilers. Further increase in electrical capacity was achieved in 1909 by adding 7500-kw vertical low-pressure turbine-generators to take exhaust of five of the engines. These five 15,000-kw combination units, which were more efficient than any single turbine-generators then available, are still in service and operate at peak load periods.

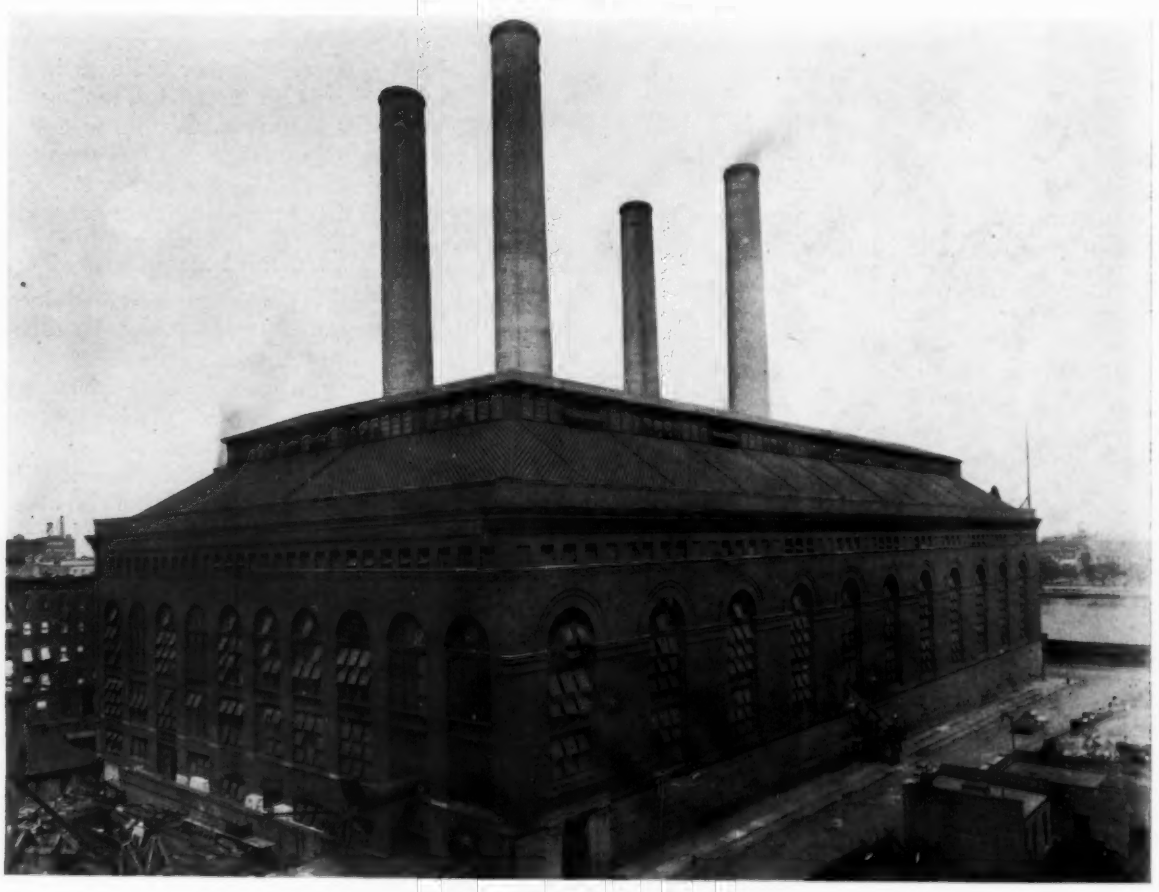
Three 35,000-kw turbine-generators were added in 1917–1918, at which time a much-needed increase in steam capacity was obtained through replacement of the old stokers with those of a then modern underfeed type, although these stokers are not well adapted to the grades of coal now most generally available. Later, in 1924, in order to bring the steam generating capacity more closely in line with the electric generating capacity, four 120,000-lb-per-hr stoker-fired boilers were added. Some twenty years later, in 1946, a 600,000-lb-per-hr, 1350-psig, pulverized-coal-fired boiler and a 62,500-kw turbine-generator were installed in an extension to the original plant.

Seventy-fourth Street Station

This plant was built by the Manhattan Railway Company in 1902 to furnish power for the Manhattan Elevated System, which was then in the process of being electrified. This company was amalgamated with the Interborough Rapid Transit Company in 1904. Later, in conjunction with Fifty-ninth Street, it also served the subway system, and for a time the surface lines. Initially it contained seventy boilers,



Interior of Seventy-fourth Street Station



Seventy-fourth Street Station

located on two operating levels and eight engine-driven units similar to those in Fifty-ninth Street. The original operating pressure of 160 psig was later raised to 185 psig for the engines and in 1915 to 215 psig for the turbines, the first of which was installed in 1905.

Steam capacity was doubled in 1913 by the installation of underfeed stokers and work was begun on the installation of three 30,000-kw cross-compound turbine-generators. These replaced four of the engine-driven units. In 1918, there was added a 60,000-kw triple-cylinder, cross-compound turbine-generator unit. Superheaters were added to some of the boilers to raise the temperature from 380 F to 600 F for the turbines. The first of two 66,000-kw, 60-cycle, 1250-psig turbine-generators and two high-pressure pulverized-coal-fired boilers have been purchased and are now under construction for initial operation in 1953, at which time it is proposed that sixteen of the old boilers be removed. The remaining engine-driven units will be removed this spring.

Incidentally, it may be mentioned that these two plants under the supervision of the late H. G. Stott, superintendent of motive power, served as the training ground for a number of young engineers, referred to as "Stott's boys," who have since attained outstanding prominence in the power field.

Kent Avenue Station

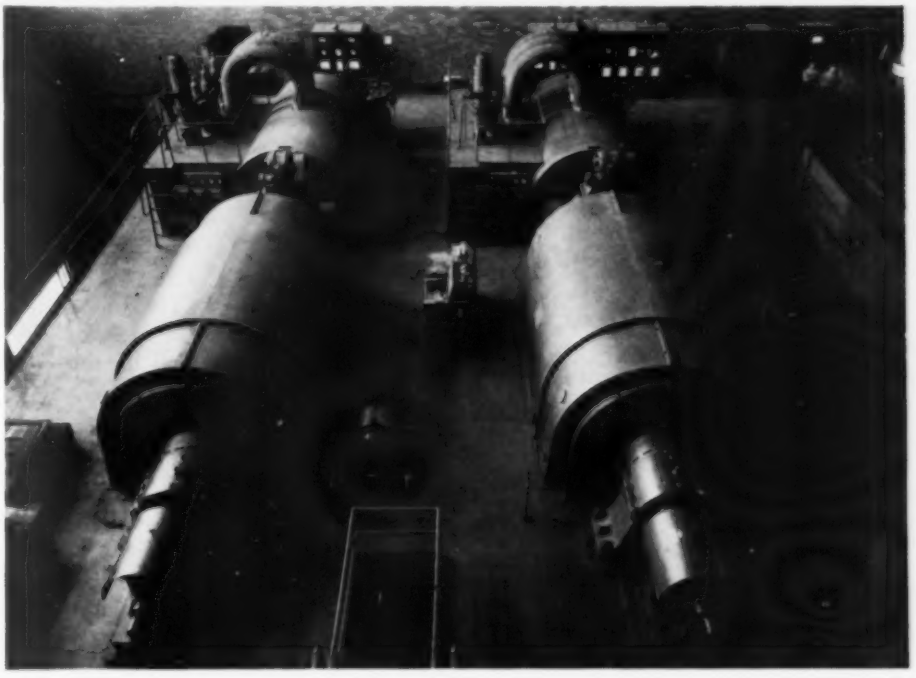
This plant was built in 1905 by the Brooklyn-Manhattan Transit Corporation to serve the elevated and surface lines in Brooklyn and later took on the BMT subway load. The original steam generating equipment consisted of 72 boilers of 200-psig pressure. The initial three 7500-kw turbine-generators were soon followed by four 10,000-kw units. In 1913, a 20,000-kw machine was added, followed in 1917 by a 30,000-kw unit, and in 1920, by two 35,000-kw units. Later, in 1938, two 850-psig boilers were installed to supply two topping turbines exhausting at 200 psig to the 35,000-kw units.

These plants were privately owned and operated prior to 1940, at which time the City took them over, with their respective transit lines, to comprise a unified system including the already city-owned Independent Lines, all of which are operated under the Board of Transportation.

At the time this unification was put into effect the Board of Transportation engaged The J. G. White Engineering Corporation to make a technical survey of the existing power facilities and prospective requirements with recommendations covering modernization and extension, but World War II interfered with the carrying out of the recommendations. However, a supplementary report was made in 1945, which resulted a year later in installation of the high-pressure extension at Fifty-ninth Street, as previously mentioned.

Recommendations

The latest report states that since purchase of the privately owned transportation lines in 1940, the City has failed to keep pace with current practice in power supply, with the result that cost of power production is relatively high and reliability is jeopardized. The following recommendations are made:



Topping turbines in Kent Avenue Station

FIFTY-NINTH STREET

1. That complete new coal- and ash-handling systems be installed, with work starting in 1952.

2. That a second 62,500-kw, 25/60-cycle, high-pressure turbine-generator, together with its boiler and auxiliaries, be added immediately, and upon completion that twelve old boilers and two of the engine-generator units be removed.

3. Installation of a 30,000-kw, 25/60-cycle frequency converter.

4. That upon completion of the second 62,500-kw turbine-generator, two additional 66,000-kw, 60-cycle units, together with high-pressure boilers and auxiliaries, be installed, followed in 1956 by demolition of two of the remaining engine units and sixteen old boilers. The

remaining old boilers, engines and two of the early turbine-generators would be removed in 1958.

SEVENTY-FOURTH STREET

1. The 25-cycle turbine-generators appear to be in good condition.

2. It is proposed that a third high-pressure boiler with auxiliaries and the second 66,000-kw, 60-cycle turbine be ordered in 1952. Sixteen of the old boilers would be retired by the middle of 1954.

KENT AVENUE

1. That an immediate start be made on the installation of new coal- and ash-handling facilities to serve both the old and the new boiler houses.

2. That work be initiated leading to the installation of a third 850-psig boiler to offset the unsatisfactory condition of the old boiler house, and that work be started next year on demolition of the three oldest turbine-generators.

3. That a fourth high-pressure boiler and a new 66,000-kw, 60-cycle turbine-generator be installed upon completion of the third boiler; this to be followed by removal of all equipment in the old boiler house.

NEW POWER PLANT

Despite the foregoing modernization program and additions, it is believed that this will not be able to supply contemplated extensions to the transportation system, together with the Second Avenue Subway. Therefore, it is recommended that a new high-pressure power plant, to contain initially two 95,000-kw, 60-cycle units, be started not later than 1954.

Further recommendations are made concerning additional frequency converters, switching stations, high-tension interconnection of the power plants and substantial ties with the Consolidated Edison system, so that the whole system power supply may be integrated and assure uninterrupted service.

Power Costs

The report raises the point that, basically, city-generated power should be expected to cost less to the city than purchased power because of freedom from taxes, the enjoyment of a lower interest rate and the absence of dividends, despite somewhat higher efficiency of generation by a private utility. But in making comparisons the fact that the City receives taxes upon power purchased from a utility must be taken into consideration in studying the problem.

As of June 1950, average purchased power cost, on the Independent Lines, was 1.098¢ per kwhr, as compared with city-generated power at 1.424¢ per kwhr. The estimated cost of city generation with the recommended modernization and present costs of fuel and labor is 1.198¢ per kwhr. However, it is to be noted that the purchased power rate is based on an old contract which was temporarily extended pending approval and acceptance of a new proposed rate which was substantially higher to cover increased costs.

In making available a copy of the report, upon which the foregoing digest is based, COMBUSTION wishes to express its appreciation to the Mayor's Committee on Management Survey and to The J. G. White Engineering Corporation for their cooperation.

Facts and Figures

The per capita use of electricity in the United States for the year 1951 exceeded 2800 kwhr.

•

The 200-in. Palomar telescope can peer into space for a distance equal to that which light travels in a billion years.

•

In the last ten years the production per man-day of American coal mines has increased approximately 34 per cent.

•

Hard-bonded deposits on the gas side of boiler tubes are generally composed of water-soluble constituents.

•

The average rating of 3600-rpm turbine-generators now building is over 70,000 kw.

•

Oil-bearing strata are now being detected through application of neutron radiation. This has been most useful in arriving at estimated reserves.

•

Saturated steam gives up heat more readily than superheated steam, hence is employed in preference to the latter for process work involving heat transfer.

•

The unit system of one boiler per turbine has taken hold in Britain where it is being applied to more than a third of the capacity now under construction by the British Electricity Authority.

•

According to International Nickel Company, a ton of ore must be mined and processed to produce 27 pounds of nickel.

•

Attainable power through direct utilization of the sun's rays under most favorable known conditions is estimated to be about 50 hp per acre per hour.

•

This country is said to possess about forty per cent of the world's coal with estimated reserves, covering all ranks, amounting to about 986 billion tons.

•

The average thermal efficiency of British central stations, as reported for the twelve months ending March 31, 1951, was 21.54 per cent and the coal consumption per kilowatt of energy *generated* was 1.45 lb.

•

The Bureau of Mines reports that dust hazards in a western bituminous coal mine were decreased 70 to 90 per cent by drilling holes in the coal pillars and forcing water through them into the cracks and crevices of the bed several days before actual mining operations were started.

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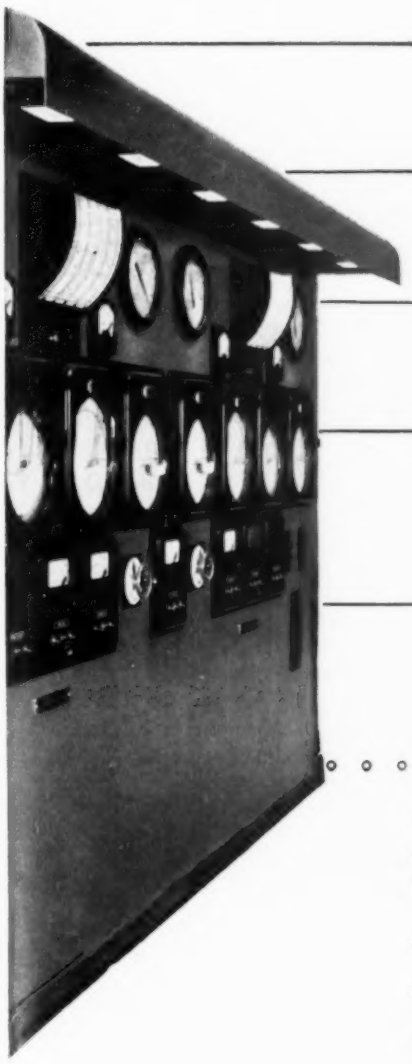
COMBUSTION CONTROL SYSTEM ?



Low maintenance?

"We find that due to the (Hays) properly controlled combustion, our maintenance on both stokers and boilers has been considerably decreased."

American Tobacco Company

Good CO_2?

"CO_2 readings show that on an average day our CO_2 varies between 13% and 14% despite load fluctuations."

Sunshine Biscuits, Inc.

Increased efficiency?

"Operating efficiency has been as high as 82%—much of the credit going to the accuracy of (Hays) automatically controlled combustion."

Sherwin Williams, Chicago Plant

Fuel savings?

"We estimated that . . . we would be able to pay for the new equipment (Hays Combustion Control) out of fuel savings in three years. Since then, the records show that the amortization of the original investment has been accelerated."

Raybestos—Manhattan, Inc.

Rapid response to wide load swings?

"We have made test runs using the Hays system, bringing the load rapidly up from 8,000 to 80,000 lbs per hour with excellent results. Fuel-air ratio was held at the desired value and CO_2 at 15%."

Bemis Brothers Bag Company

You want the specific results to solve your combustion problems. Hays engineers have the experience to give you results like:—

- **smoke abatement**
- **reduced labor costs**
- **decreased outage**
- **constant steam pressure**
- **lower fuel bills by switching fuels**
- **firing mixed fuels efficiently**
- **rapid response to steam demand**

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Send a statement of your combustion problem and the results you want to Orval W. Riggs, Mgr., Application Engineering, The Hays Corporation, Michigan City 3, Ind. You will receive: 1. Our preliminary recommendations for a solution to *your* problem. 2. Hays' 48-page booklet on control systems and how they work. 3. Five "Case Histories", telling how leading companies got "results" on five different problems with

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Thermal Performance of Modern Turbines*

By H. R. REESE† and J. R. CARLSON‡

Data are presented on heat rates to be expected for units of 75,000 to 200,000 kw capability operating on the regenerative cycle with various steam conditions from 850 psig, 900 F to 2400 psig, 1100 F and various stages of feedwater heating; also with the combined regenerative and re-superheating cycles. Charts show the heat added per pound of steam in the reheater and figures are included for steam conditions of 1450 psig, 1000 F and 1800 psig, 1050 F, to show the reduction in heat rate for various stages of feedwater heating and the optimum final feed temperature.

ABOUT eleven years ago the job of organizing and rationalizing large turbine efficiencies, for submission to the power industry, was begun. At that time importance was placed on straight condensing turbine-generator efficiencies or steam rates, rather than on heat rates. Four initial steam conditions were selected—namely, 400 psig, 750 F; 600 psig, 825 F; 850 psig, 900 F; and 1250 psig, 950 F—which made it possible to calculate, tabulate and analyze hundreds of turbine propositions and test results. These data were printed in book form, including a curve of superheat correction factors, and distributed by Westinghouse to the industry under title "The Steam Power Plant Planning Guide."

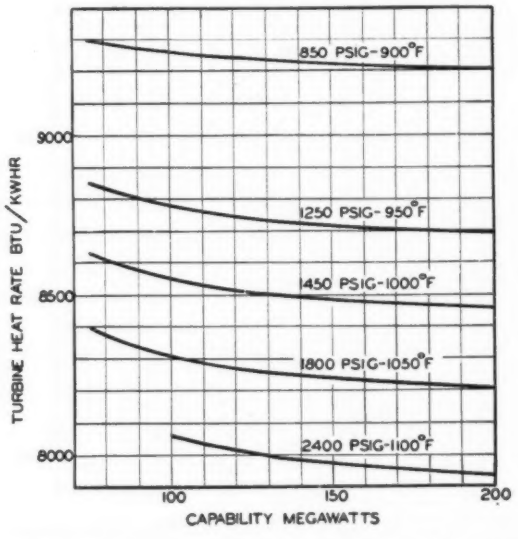


Fig. 1—Heat rates vs. capability for non-reheat turbine-generators under five basic steam conditions with five stages of feedwater heating and 1.5 in. Hg abs exhaust pressure

This booklet is still useful up to steam conditions of 1250 psig, 950 F and ratings of 60,000 kw, but today single shaft 3600-rpm turbine-generators of 150,000 kw capability will soon be shipped and single-shaft ratings of 185,000 and 200,000 kw have already been undertaken. Steam conditions for turbine ratings as low as 60,000 kw are commonly 1450 psig, 1000 F, with or without reheating, whereas pressures for larger units range upward to 2000 psi, or even higher, and 1100/1050 F. Furthermore, today little importance is attached to straight condensing efficiencies, as the heat consumption of turbine-generators in Btu per kwhr is of more direct interest. Therefore extension of data in the Guide to cover the higher temperatures and pressures was clearly indicated.

Heat rates of large non-reheat turbines from 75,000 to 200,000 kw have been calculated[1] and are presented in curve form (Fig. 1) for the following five basic well-matched steam conditions, all with an exhaust pressure of 1.5 in. Hg abs and five stages of feedwater heating:

Pressure	Steam Temp.	Final Fw Temp.
850 psig	900 F	400 F
1250 psig	950 F	435 F
1450 psig	1000 F	450 F
1800 psig	1050 F	475 F
2400 psig	1100 F	500 F

The heat rates are based on a five-stage regenerative feedwater heating arrangement similar to that shown in Fig. 2, except for omission of reheating and the sixth heater. In this arrangement the feedwater is pumped

[1] Using the formula: Heat Rate $= \frac{F(H_1 - HF)}{Kw}$, where F is the throttle flow in pounds per hour; H_1 is the initial enthalpy in Btu per pound and HF is the final feed enthalpy in Btu per pound.

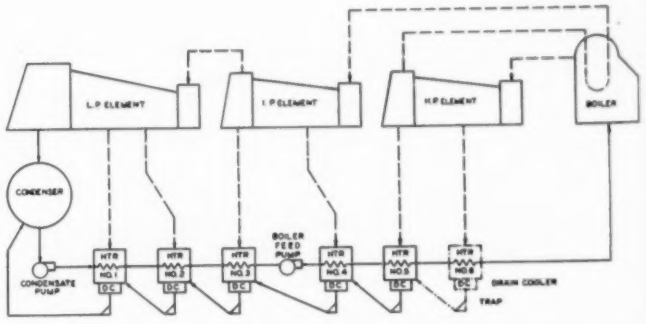


Fig. 2—General arrangement of elements of a reheat-regenerative steam cycle

* Condensation of a paper presented at the 1951 ASME Annual Meeting in Atlantic City.

† Assistant Section Manager, Steam Division, Westinghouse Electric Corp.

‡ Application Engineering Manager, Steam Division, Westinghouse Electric Corp.

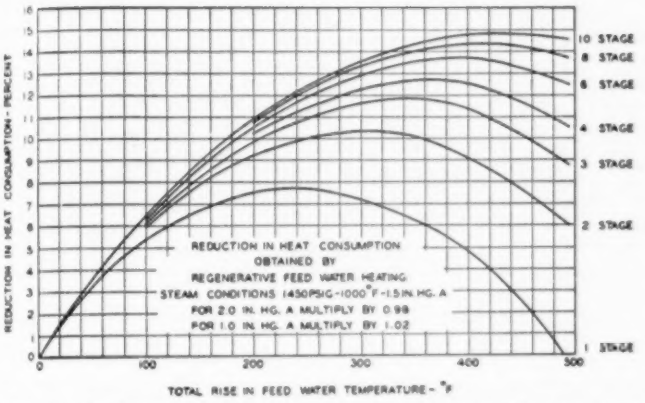

REDUCTION IN HEAT CONSUMPTION - PERCENT
TOTAL RISE IN FEED WATER TEMPERATURE - °F
10 STAGE
8 STAGE
6 STAGE
4 STAGE
3 STAGE
2 STAGE
1 STAGE
REDUCTION IN HEAT CONSUMPTION
OBTAINED BY
REGENERATIVE FEED WATER HEATING
STEAM CONDITIONS 1450PSIG-1000°F-1.5 IN. HG. A
FOR 2.0 IN. HG. A MULTIPLY BY 0.98
FOR 1.0 IN. HG. A MULTIPLY BY 1.02

Fig. 3—Optimum feed temperature and reduction in heat rates for various heating stages, computed for 1450 psig, 1000 F

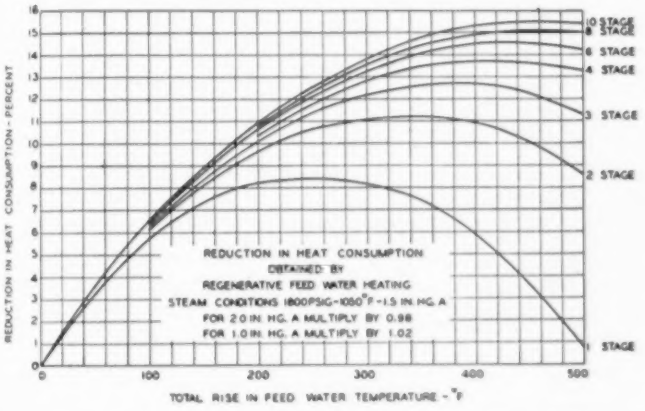

REDUCTION IN HEAT CONSUMPTION - PERCENT
TOTAL RISE IN FEED WATER TEMPERATURE - °F
10 STAGE
8 STAGE
6 STAGE
4 STAGE
3 STAGE
2 STAGE
1 STAGE
REDUCTION IN HEAT CONSUMPTION
OBTAINED BY
REGENERATIVE FEED WATER HEATING
STEAM CONDITIONS 1800PSIG-1050°F-1.5 IN. HG. A
FOR 2.0 IN. HG. A MULTIPLY BY 0.98
FOR 1.0 IN. HG. A MULTIPLY BY 1.02

Fig. 4—Curves similar to those of Fig. 3, plotted for 1800 psig, 1050 F

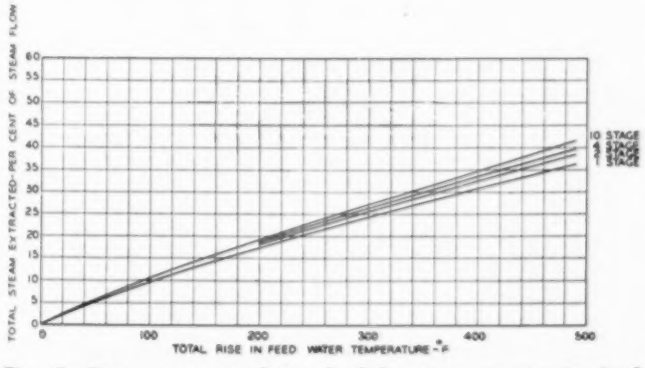


Fig. 5—Steam extracted for feed heating vs. rise in feed temperature for initial steam conditions of 1450 psig, 1000 F

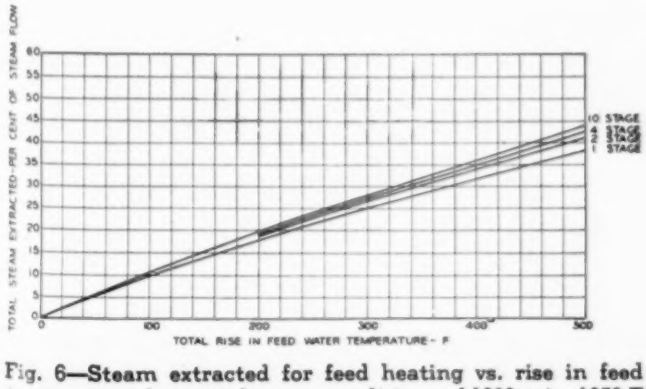


Fig. 6—Steam extracted for feed heating vs. rise in feed temperature for initial steam conditions of 1800 psig, 1050 F

from the main condenser by a condensate and boiler feed pump through five closed heaters before entering the steam generating unit, with the drains from each heater cascaded to the next lower heater through a drain cooler and that from the lowest pressure heater, through a drain cooler, to the main condenser. The heater terminal difference for the top heater was assumed as zero degrees and for the remaining heaters as five degrees. Temperature of the drains from the drain coolers was assumed as ten degrees above that of the feedwater entering the drain cooler.

Heat balance calculations for the various steam conditions were based upon a final feedwater temperature at turbine capability as tabulated, and the heat rates are based on a custom of providing 5 per cent steam flow margin over capability load at 2.5 in. Hg abs to cover variations in manufacture.

For a given kilowatt rating initial steam conditions, final feed temperature, and heat rate, it is possible to calculate the throttle flow at capability from the formula:

$$F = \frac{\text{Heat rate} \times \text{Kw}}{H_1 - H_F}$$

Curves indicating optimum final feedwater temperatures and reduction in heat rates for various feedwater heating stages, for steam conditions of 1450 psig, 1000 F, 1.5 in. Hg abs and 1800 psig, 1050 F, 1.5 in. Hg abs are shown in Figs. 3 and 4, respectively. Also, for these steam conditions Figs. 5 and 6 show the quantity of steam extracted, in per cent of throttle flow, for different numbers of feedwater heating states.

Variations from Base Conditions

For steam conditions varying from those covered by Fig. 1 correction factors are available to correct the heat rates for initial pressure, initial temperature, exhaust pressure, number of stages of feed heating, and terminal difference on the top heater.

Initial Pressure Correction

The initial pressure correction to the heat rate for a plus or minus change in pressure of 100 psi is shown in Fig. 7 for capabilities of 75,000, 100,000, 150,000 and 200,000 kw. That is, for an increase of 100 psig over a given base multiply the heat rate shown in Fig. 1 by the factor obtained from Fig. 7, and for each decrease of 100 psig divide the heat rate by the correction factor.

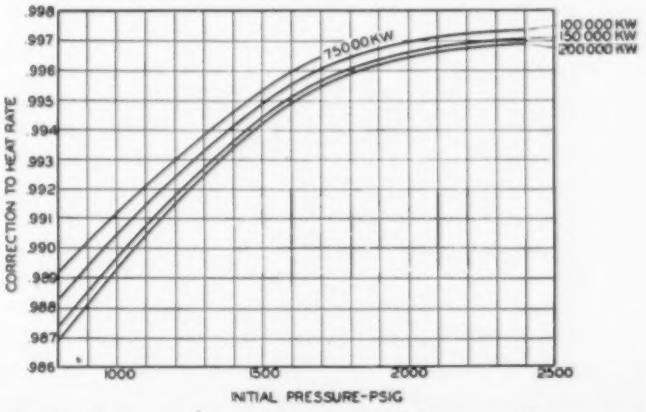


Fig. 7—Heat rate correction vs. initial pressure increment

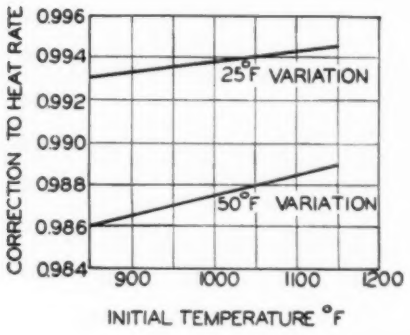


Fig. 8—Initial temperature correction to heat rate for non-reheat units

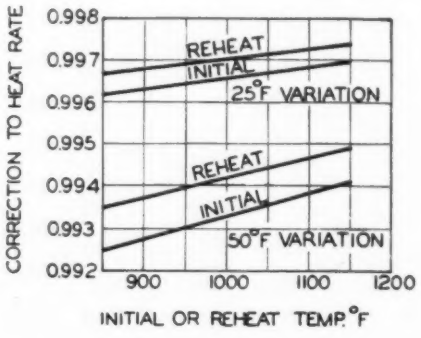


Fig. 9—Initial and reheat temperature correction to heat rate for reheat units

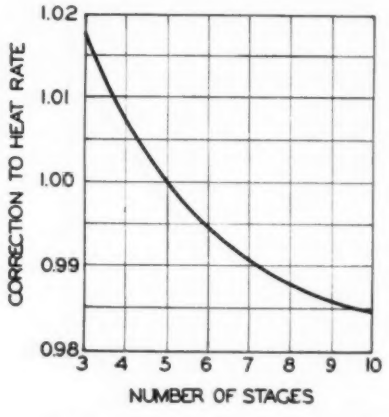


Fig. 10—Correction to heat rate for number of stages of feed heating

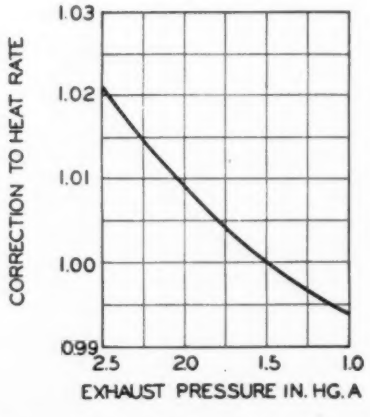


Fig. 11—Correction to heat rate for exhaust pressure

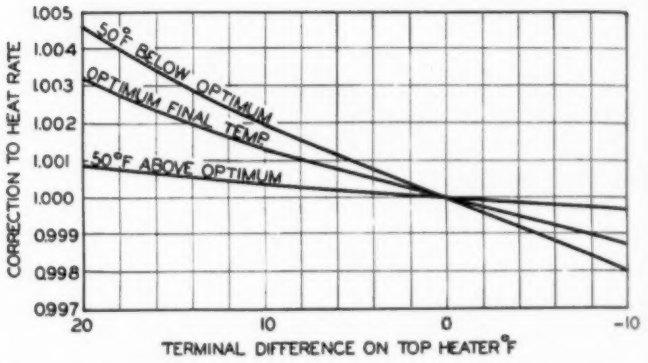


Fig. 12—Correction to heat rate for terminal difference on top heater

Corrections for Initial Temperature, Number of Feed-Heating Stages and Exhaust Pressure

The initial temperature corrections to heat rates of non-reheat units for 25-deg and 50-deg variations in steam temperature are given in Fig. 8 and for reheat units in Fig. 9. Those for various numbers of stages of feed heating are given in Fig. 10 and those for exhaust pressures other than 1.5 in. Hg abs are shown in Fig. 11, the latter values being approximate.

After the turbine heat rates have been corrected to the new conditions, throttle flow can be calculated from the formula previously given. Condenser flow will be one minus the factor in Fig. 5 multiplied by the throttle flow.

The correction for terminal difference on top heater is given in Fig. 12. For a terminal difference varying from zero degrees multiply the heat rate in Fig. 1 by the correction factor in Fig. 12. It should be noted that the correction factor decreases with final feed temperature.

Heat Rates for Reheat Units

Fig. 13 shows the heat rates for large reheat turbines of 75,000 to 200,000 kw for the following four basic steam conditions, all with 1.5 in. Hg abs exhaust:

1250 psig, 950/950 F
1450 psig, 1000/1000 F
1800 psig, 1050/1050 F
2400 psig, 1100/1100 F

All heat rates were calculated by the formula

$$\text{Heat Rate (HR)} = \frac{F(H_1 - H_F) + KF(H_R - H_E)}{\text{Kw}}$$

where

F = throttle flow in lb per hr
H_1 = initial enthalpy in Btu per lb
H_F = final feed enthalpy in Btu per lb
H_R = reheated steam enthalpy in Btu per lb
H_E = h-p turbine exhaust enthalpy in Btu per lb
$H_R - H_E$ = heat added in reheater
K = reheater flow factor

The heat rates are based on five stages of feedwater heating with the reheater pressure drop from the high-pressure element exhaust to the inlet of the interceptor valve being taken as ten per cent. The final feedwater temperatures are assumed to be the same as with the non-reheat units, and throttle flow at capability is calculated, similar to that for non-reheat units by the formula

$$F = \frac{\text{HR} \times \text{Kw}}{(H_1 - H_F) + (H_R - H_E)}$$

Heat added in the reheater $(H_R - H_E)$ is shown by the curve in Fig. 14. This heat added is based on a reheat pressure which is 25 per cent of the initial pressure.

After the throttle flow has been calculated, the reheater flow is equal to the reheater flow factor K times the

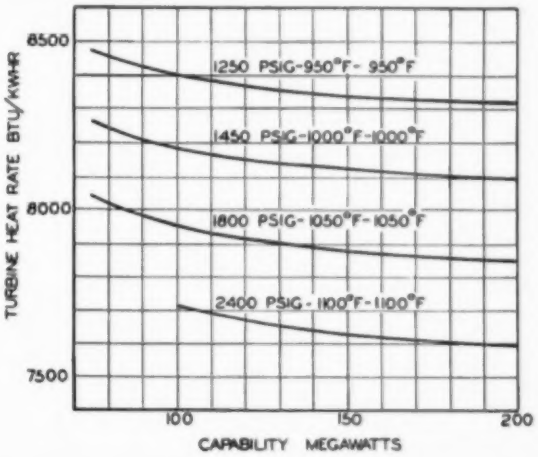


Fig. 13—Heat rate of reheat units vs. capability with 5 stages of feedwater heating and 1.5 in. Hg abs exhaust

throttle flow. The condenser flow is equal to one minus the extraction factor (see Figs. 5 and 6) times the throttle flow.

For steam conditions other than the five basic values assumed, the correction factor to be used is that covered under non-reheat units, except the initial temperature

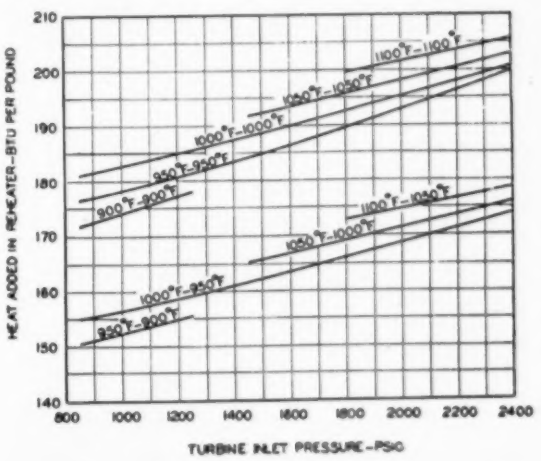
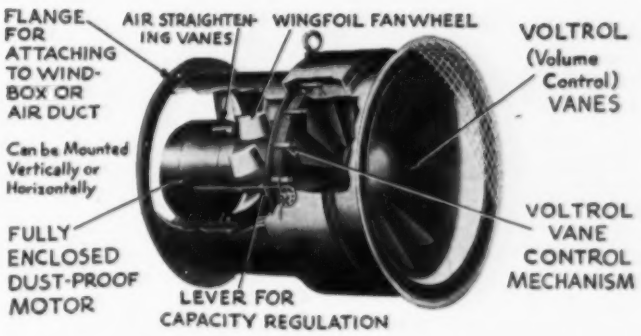


Fig. 14—Heat added in reheater vs. turbine inlet pressure, for reheat pressure 25 per cent of initial

correction factor which is shown in Fig. 9 for reheat units, which also contains the reheat temperature correction factors.

After the turbine heat rates have been corrected to the new steam conditions, throttle, reheater and condenser flows can be calculated from the formula previously given.

The authors acknowledge the assistance of C. B. Campbell in the preparation of this paper and of Messrs. D. R. Cobb and J. H. Sturgis in the preparation of curves and other data.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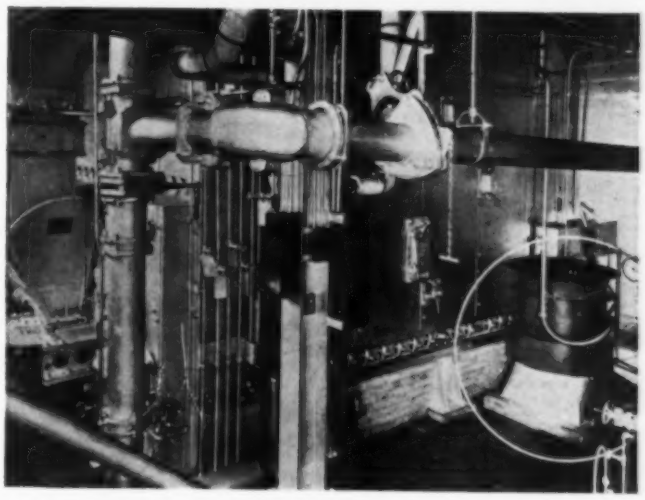

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More Court Decisions*

By LEO T. PARKER

Attorney at Law, Cincinnati, Ohio

ORDINARILY plant owners, managers or operators are so engrossed in their business or daily routine that they do not heed things that may lead to legal controversies. However, many lawsuits could be avoided if they were to become more familiar with the causes of such actions and the consequent later decisions of the higher courts, some of which reverse older interpretations of the law. Even where litigation is unavoidable, knowledge of such decisions can be advantageously utilized in winning law suits.

Enlargement of Plant

A higher court recently held that a company which owns a steam-operated plant can continue to do business at a given site irrespective of new zoning laws, but that it cannot use the premises for any new business, nor otherwise enlarge the existing plant.

In the case of *Everpure Manufacturing Co. v. Board of Appeals, 86 N.E. (2d) 906*, testimony showed that the company had been in the ice manufacturing business for many years when the city enacted an ordinance classifying the district as exclusively residential. The court held that since the company was established in the now restricted locality before the ordinance was passed, its manufacturing business was not affected by the new zoning regulations.

Later, the company, in order to make more profitable use of the premises, desired to enlarge the plant and filed an application with the building inspection department for a permit; but the latter refused to grant the permit. The court approved the inspector's ruling, saying:

"The only existing structure on the lot is the ice plant and the only existing use to which the locus is devoted is the making and distribution of ice."

A comparable situation arose where a plant in a restricted area burned down and the court, despite the zoning ordinance, permitted it to be rebuilt with the provision that the height and area occupied by the destroyed building should not be exceeded.

Vibration from Machines

A somewhat similar case was that of a manufacturing company which had been operating at the same location for about 25 yr and decided to install a new machine of a type that made a noise quite distinct from that of the other machines. A near-by property owner filed suit and asked the court to grant an injunction against installation of the new machine on the grounds that it would constitute a nuisance.

Here the higher court in *Finn v. Pasquini 49 Atl. (2d) 858* refused to grant the injunction but indicated that, although the company could continue using the same equipment it had previously used, if the new machine proved to be a nuisance to persons living nearby the lower court must issue an injunction against its use.

City Ordinance Against Smoke

It is generally recognized that whatever is injurious to health, or deprives people of pure uncontaminated air, is a public nuisance.

In the case of *Penn-Dixie Corp. v. City of Kingsport, 225 S.W. (2d) 270*, it was shown that the city had enacted an ordinance prohibiting the emission of dense smoke or dust from any stack or chimney.

The right of the city to enact such an ordinance was challenged by the counsel of the manufacturing corporation on the ground that the state had not delegated to the city the right to enforce laws involving the abatement or regulation of excessive smoke and dust. Nevertheless, the higher court sustained the validity of the ordinance and said:

"The law has never been so inconsiderate of public welfare as to impose upon a municipality the necessity of obtaining specific legislative authority before it can cope with every condition that may be detrimental to the health of its people. If a municipality must have specific authority, either by a charter provision or under some general law, to enable it to deal with every cause or condition that is detrimental to public health, the legislature would be compelled to adopt as many enabling acts as there are conditions thought to be dangerous to the community."

Mechanic's Lien v. Chattel Mortgage

Generally speaking, a valid mechanic's lien cannot be filed against personal property, since such a lien is applicable solely to real property. However, according to a late higher court decision, a mechanic's lien is valid against personal property when attached permanently to real property. Also, a new mechanic's lien has priority over an older chattel mortgage.

In *Stapp et al. v. Carb-Ice Corp. et al., 224 Pac. (2d) 935*, testimony showed that the Stapp Engineering Company had entered into a contract with the Carb-Ice Corporation to "design, build and construct a plant to produce liquid and solid carbon dioxide, using boiler flue gas as a source of the basic material." The plant was to be constructed on real estate owned by the Colorado Ice & Cold Storage Company upon which property the Carb-Ice Corporation had a twenty-year lease.

After the work had been completed, the engineering company sued Carb-Ice for an alleged balance due, claiming that the total cost of material furnished and labor performed was $278,435.16 and that the Carb-Ice Corporation had paid only $263,684.57, thus leaving a balance of $14,750.59, plus interest. The engineering company filed a mechanic's lien against the plant and real property of the Carb-Ice Corporation to secure payment of this balance. The property included the machinery installed in the plant.

* While many of these cases cited in Mr. Parker's periodic articles directly involve steam power plants, others are applicable to problems that occasionally confront engineers.—EDITORS.

Testimony showed that a bank had loaned money on the machinery and equipment and held a chattel mortgage on it. Officials of the bank contended that the chattel mortgage was prior to the mechanic's lien, first because it was recorded before the lien was filed and, secondly, a mechanic's lien is not valid on personal property.

However, the higher court held that the machinery and equipment automatically became real property when it was attached to the real property, and further that the mechanic's lien had priority over the chattel mortgage, even though the latter was filed earlier. In this respect the court said:

"We must assume the truth of the statement which discloses that the contract entered into by Carb-Ice was to 'design, build and construct a plant' and that the items included in the chattel mortgage running to The First National Bank of Denver were a necessary part of the plant and machinery required for the successful operation of the whole plant. Items of personal property may become subject to a mechanic's lien by becoming fixtures."

Inventor Controls Patent

This question is often asked: Can an inventor of a patent that is valuable and important to the general public refuse to manufacture or permit others to manufacture, sell or use it? According to court decisions in this country, the answer is yes.

For example, in the case of *United States v. Harvey Steel Co., 196 U.S. 310*, the court held that the owner of a patent can pigeon-hole it if he so desires and need not allow anyone to make, sell or use it during its 17-yr duration. But after the expiration of a patent, the patentee has no further rights to it; nor can he extend its life. He may obtain a new patent on improvements, but the new patent must be confined strictly to such new improvements and any person, firm or corporation may without liability make, sell or use the old patented invention.

Must Warn Employees

The courts have consistently held that employers are obligated to warn employees of special dangers and to supply them with special clothing or equipment for protection against injury. The following is a case in point:

In *Levesque v. Clearwater Mfg. Co., 41 S.E. (2d) 92*, an employee sued his employer for damages for illness which he claimed resulted from working with certain chemicals in a boiler room. He suffered pain, itching and sores, was treated by a physician and hospitalized. He contended that before being permitted to handle these chemicals his employer should have warned him of the dangers and provided the necessary safeguards.

The higher court agreed with this contention and awarded damages.

Not Within Scope

According to a recent higher court ruling an employee may sustain an injury, or be killed *in the course* of his employment, without compensation being allowable under the State Workmen's Compensation Act, unless the testimony proves that the injury or death occurred *within the scope* of his employment.

For example, in *Jefferson Ice Company v. Industrial Commission, 88 N.E. (2d) 837*, the testimony showed that one Graf had been employed by the mentioned company for many years as a stationary engineer at night, at which time the only other employee on duty was an ice puller who worked under Graf's supervision. In the performance of his duties as an engineer Graf had to check the ammonia compressors in the engine room. One night Graf was killed in an alley adjacent to the engine room.

In subsequent litigation the higher court refused to award Graf's dependents any compensation.

Heavy Damages Awarded

It is generally held that a contractor is not liable for injuries to employees or third persons unless the testimony proves that such injuries resulted from the contractor's negligence. However, this rule is not applicable when the court decides that the doctrine of *res ipsa loquitur* is applicable. This is founded on the hypotheses that the instrumentality producing the injury was under the management or control of the contractor and that, in the general experience of mankind, the event producing the injury does not happen unless the person in control has failed to exercise due care.

For illustration, in *Morme v. Deakman Company, 69 Atl (2d) 212*, it was shown that a 1200-lb, 9 × 12-ft metal-covered fire-door was temporarily leaned against a building. The door was not braced and an employee was killed when the door fell on him.

In the subsequent litigation the court sustained an award of $25,000 damages without proof that the contractor was negligent when placing the door against the building without properly bracing it. In other words the court held that carelessness of the contractor in not securely fastening the fire-door in its temporary position brought into effect the doctrine of *res ipsa loquitur*.

Must Warn Plant Engineers

According to a late higher court decision, a gas company is liable for explosion of gas in a steam plant where testimony showed that the gas company's employees had good reason to believe that gas was escaping and likely to endanger the plant, and such employees failed to warn the engineers in the plant.

In the case of *Davis v. Kansas Electric Power Company 152 Pac. (2d) 806*, suit was filed against the gas company for injuries sustained by an engineer named Davis and for real property damaged as the result of a gas explosion and consequent fire in the plant. It was contended that the injuries which Davis sustained, as well as the property damage, resulted from negligence of the gas company employees in permitting natural gas to escape from the gas company's mains into the basement of the power plant.

During the trial testimony was given to the effect that just prior to the explosion employees of the gas company had dug down to the gas main and cut a hole in the main for attaching a meter. In view of this testimony the jury rendered a verdict against the gas company. The court approved the verdict and said:

"After having discovered the extent of the gas leaking from the main, the company had not cautioned plaintiff that there might be gas leaking into the building or basement."

First Annual Meeting of the American Power Conference

THE Midwest Power Conference, which had been held in Chicago for thirteen years, progressively increased in size, scope and importance to the point that it no longer was regional in character. For this reason it was decided to change the name this year to "American Power Conference" as more descriptive, under which designation the first meeting will be held in Chicago, March 26-28, at the Sherman Hotel. It will be under the same sponsorship as in former years, namely, the Illinois Institute of Technology with a group of midwestern universities, local sections of the national engineering societies, the Edison Electric Institute and the Association of Edison Illuminating Companies cooperating, under the direction of Prof. R. A. Budenholzer. The tentative program is as follows:

Wednesday, March 26

9:00 a.m. Registration, Sherman Hotel.

10:00 a.m. Opening Meeting in Grand Ballroom. Chairman: Edward J. Doyle, Commonwealth Edison Company.

Address of Welcome—Hon. Martin H. Kennelly, Mayor of Chicago.

Address—George M. Gadsby, president, Edison Electric Institute.

Address—C. H. Lang, vice president, General Electric Co.

12:15 p.m. Luncheon sponsored by Chicago Section of ASME, with Alex Bailey presiding. Speaker—Pressly H. McCance, president, Association of Edison Illuminating Companies.

2:00 p.m. Central Station Steam Turbine Generators. G. A. Gaffert, chairman.

"Thermal Efficiency and Design of High-Temperature and Reheat Turbine-Generator Units," by T. R. Carlson, Westinghouse Electric Corp.

"Controls of Modern Steam Turbine-Generator Units," by Charles F. Wilson, Allis-Chalmers Manufacturing Co.

2:00 p.m. Industrial and Small Plants. John H. Herzog, chairman.

"The Development and Application of Water-Tube Package Steam Generators, by N. O. Kirkby, Vapor Heating Corp.

"Coal Dust Control with Liquid Diffusion Compounds," by G. A. Mau, Johnson March Corp.

2:00 p.m. Electrical Distribution. D. D. Ewing, chairman.

Papers to be announced later.

3:30 p.m. Modern Steam Generators. Frank D. Carvin, chairman.

"Trends in Modern Central Station Boiler Design," by H. B. Wallace, Jr., Foster Wheeler Corp.

"Considerations in the Design of Large Central Station Boilers," by W. A. Rowand, Babcock & Wilcox Co.

3:30 p.m. Training of Power Plant Operating Personnel. Leslie F. Clifford, chairman.

"Human Relations in Personnel Practice," by Stephen C. Casteel, East St. Louis and Interurban Water Co.

"Experiences and Results of Personnel Training Courses," by O. P. Stamtal, Union Electric Co. of Missouri.

"Present and Future of Personnel Training in the U. S. A.," by W. F. Patterson, U. S. Department of Labor.

3:30 p.m. Industrial Systems. Fred W. McCloska, chairman.

"Interconnection of Industrial and Public Utility Systems," by V. F. Estcourt, Pacific Gas and Electric Co.

"Electric Arc Furnaces as an Electric Utility Load," by B. M. Jones, Duquesne Light Co.

7:30 p.m. Session on Outlook for American Free Enterprise. J. B. Thomas, chairman.

"Federal Power in the Missouri Valley," by N. Bernard Gussett, Iowa Power and Light Co.

"Necessity of Coordinating Efforts to Maintain the American Free Enterprise System," by Leo E. Brown, American Medical Association.

Thursday, March 27

9:00 a.m. Water Technology Session No. 1. Symposium on Ion Exchange. Louis Wirth, Jr., chairman.

"Demineralization Plant Operational Experiences," by M. E. Brines, Dow Chemical Co.

"Initial Operation of a 500-gpm Duplex Deionizing Plant," by T. P. Harding, Omaha Public Power District.

"Hot Lime Zeolite—A 290-F Installation," by A. Simpson, Macon Kraft Paper Co.

9:00 a.m. Power Plant Auxiliary Equipment. Elmer C. Lundquist, chairman.

"Recent Developments in High-Pressure Boiler Feed Pumps," by I. J. Karassik, Worthington Pump and Machinery Corp.

"Demand Performance-Fluid Drive in the Modern Power Plant," by Ben Ragland, Hydraulic Coupling Division, American Blower Corp.

9:00 a.m. Electrical Transmission. J. A. M. Lyon, chairman.

"Experience with 230-Kv on Large Power Systems," by A. A. Osipovich and H. L. Rorden, Bonneville Power Administration.

"Conductor Size—Its Technical and Economic Effects on Transmission and Distribution," by R. M. Butler, General Electric Co.

10:30 a.m. Hydro Power. E. Montford Fucik, chairman.

"The Multipurpose Columbia River Development Program," by Erwin C. Hannum, Bonneville Power Admin.

"Kemano-Kitimat, Producer of Packaged Hydro Power," by F. L. Lawton, Aluminum Laboratories Limited.

10:30 a.m. Public Utility Noise Problems E. T. Vincent, chairman.

"Noise Problems and Prevention of Noise in Public Utility Properties," by W. F. Friend, Ebasco Services, Inc.

"Determination of Design Characteristics for Noise Control of Power Plants," by H. C. Hardy, Armour Research Foundation.

12:15 p.m. Luncheon sponsored by Chicago Section of A.I.E.E., W. M. Ballenger, chairman. Presiding: Walker Cisler, President, The Detroit Edison Co. Speaker: Philip Sporn, President, American Gas and Electric Service Corp.

2:00 p.m. Public Attitude and What Can Be Done About It.

"What the People Think About Socialism," by Claude Robinson, Opinion Research Corp.

"Our Responsibility in Correcting Socialist Ideology," by Edwin Vennard, Middle West Service Co.

2:00 p.m. Steam Condensers—Louis XVI Room. J. W. Andeen, chairman.

"Fundamental Designs and Design Considerations of Industrial Condensers," by G. H. Putnam, Ingersoll Rand Co.

"Condenser Circulating Pump Intakes," by W. W. Wiltmer, Allis-Chalmers Manufacturing Co.

3:30 p.m. Central Station Power Plants. Ben G. Elliott, chairman.

"Design Features of the Oak Creek Station," by O. J. Stallkamp, Wisconsin Electric Power Co.

"The Joppa Steam Electric Station," by Ralph Moody, Union Electric Company of Missouri.

3:30 p.m. Magnetic Amplifiers and Servo Mechanisms for Power Control. Alva J. Ward, chairman.

"Magnetic Amplifiers for Power Control," by E. L. Harder, Westinghouse Electric Corp.

"Servo Mechanisms in the Power Industry," by M. A. Edwards, General Electric Laboratories.

6:45 p.m. All-Engineers Dinner. Toastmaster: James J. Nance, president, Hotpoint, Inc. Speaker: Leland I. Doan, pres., Dow Chemical Co.

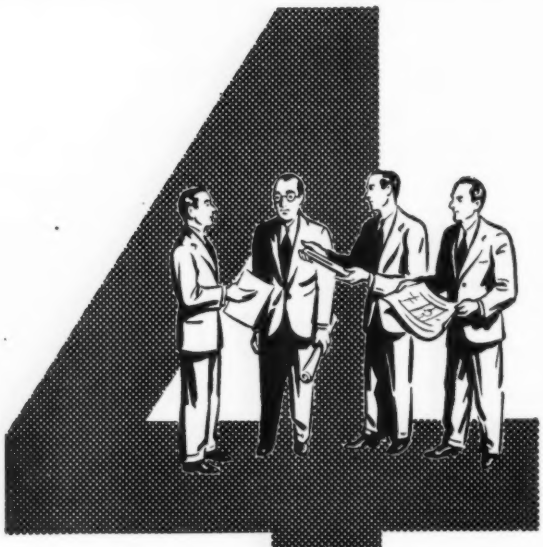
Friday, March 28

9:00 a.m. High Voltage Equipment sponsored by Power Group, Chicago Section, A.I.E.E. T. H. McGreer, chairman.

"Testing, Rating and Application of High-Power High-Voltage Circuit-Breakers," by C. L. Killgore and Byron Evans, U. S. Bureau of Reclamation.

"Lightning Arrester Protection of Substations," by E. R. Whitehead, Illinois Institute of Technology.

9:00 a.m. Water Technology Session No. 2. Corrosion in Central Stations.



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"Water Tube Corrosion in British Power Stations," by E. W. F. Gillham and R. S. Rees, British Electricity Authority.

9:00 a.m.–12:00 noon. Symposium on Diesel Power Plants.

"Study of Operating Costs of Large Slow-Speed Diesel Engines Versus Gas Turbines," by J. Byron Sims, supt. of public works, Grand Haven, Mich.

10:30 a.m. Utilization of Electric Power.

"Load Research as a Guide for Selective Selling," by C. M. Turner, Cincinnati Gas and Electric Co.

"Selective Selling Based on Load Research," by George E. Whitwell, Philadelphia Electric Co.

10:30 a.m. Fuels Session. G. Ross Henninger, chairman.

"The Place of Lignite as a Fuel for the Middle West," by Alex Burr, director of research, North Dakota Research Foundation, and chief of the Fuels Technology Division, Region V, U. S. Bureau of Mines, Bismarck, N. D.

"The Processing of Coal," by A. D. Singh, president of the Singh Co.

12:15 p.m. Luncheon sponsored by the Western Society of Engineers. Donald H. Becker, presiding. Speaker: William J. Grede, president, National Association of Manufacturers.

2:00 p.m.–5:00 p.m. Gas Turbines. J. T. Rettaliata, chairman.

"Gas-Turbine Power Plant Designs," by T. J. Putz, Westinghouse Electric Corp.

"Operating Experiences with Gas Turbines," by Paul R. Sidler, Brown Boveri Corp.

"Progress Report on the Coal-Fired Gas Turbine Locomotive," by J. I. Yellott, director of research, Locomotive Development Committee, Bituminous Coal Research, Inc.

2:00 p.m. Water Technology Session No. 3—Corrosion Problems.

"Protecting Heating Units in Condensate Lines Against Corrosion," by G. A. Mierendorf, Supt. of power plants, A. O. Smith Corp.

"Control and Prevention of Iron Oxide Deposits in High-Pressure Boilers," by R. C. Ulmer, E. F. Drew & Co.

2:00 p.m.–5:00 p.m. Symposium on A-C Network Analyzers. Eric T. B. Gross, chairman. Speakers: E. A. Baldini, The Detroit Edison Company; M. A. Faucett, University of Illinois; F. H. Howell, American Gas and Electric Service Corp.; A. J. Krupy, Commonwealth Edison Co.; James E. Van Ness, Northwestern University and E. B. Phillips, University of Kansas.

2:00 p.m. Water Technology Session No. 4, Power Plant Water Problems. W. W. Tomes, chairman.

"The Chemical Treatment of an Evaporator at West Springfield Station," by A. R. Haskins, Jr., Western Massachusetts Electric Co.

"Feedwater Treatment at Illinois State Institutions," by R. W. Lane, chemist, State Water Survey Division, State of Illinois.

AIEE Winter General Meeting

More than 3600 engineers were present for the 1952 Winter General Meeting of the American Institute of Electrical Engineers held in the Hotel Statler, New York City, January 21–25. A number of papers on generator cooling, Italian power stations, use of calculating machines in power plants, and pipe line operation were of interest to engineers in the steam power field.

As the keynote speaker, **Charles E. Wilson,** director of the Office of Defense Mobilization, observed that we are entering the Buck Rogers era of weapons development, the age of nuclear fission, supersonics and electronics. Considering the high state of creativeness in technology, there is a strong need for future planning to assure preparedness and close liaison between the armed forces and private industry. As a result of the intensive period of mobilization the United States should be more capable of waging all-out war or all-out peace with greater production facilities for electric power, steel, chemicals and petroleum than was the case in World War II. Noting that 7 million kilowatts were added during 1951 to the nation's electric power capacity, and that an addition of nearly 10 million kilowatts is planned for this year, Mr. Wilson announced that over the total mobilization period the aim is to increase the power capability by 40 per cent above that at the end of 1951.

Clarifying Technical Language

The long-standing problem of how engineers can make themselves more readily understood both in speech and written word to their colleagues and the public was discussed by three members of the faculty of New York University. **Dean O. J. Drake** and **Prof G. R. Sargent** felt that most technical speeches lack the human touch and urged that engineers attempt to clarify and not mystify. It is important to avoid trying to tell listeners too much and to arrange ideas so that members of the audience see their relation to the subject early in the speech. Along this same line, a technical talk is not to be treated as a murder mystery, and the listener is entitled to know what the speaker intends to convey.

In another address on "Writing Visually" **Prof. E. J. McAdam, Jr.,** advised the engineer to keep in mind the type of person who is to read a projected paper and neither talk down to him nor overestimate his knowledge and information. The use of easily understood analogies helps to give a picture of what is being written about and serves to clarify difficult subjects.

Generator Cooling

Two papers on generator cooling were presented, one by **Sterling Beckwith** of Allis-Chalmers Manufacturing Company entitled "Supercharged Hydrogen Cooling of Generators" and the other by **R. A. Baudry, P. R. Heller** and **H. K. Reamey,** Jr., of Westinghouse Electric Corporation, "Improved Cooling of Turbine-Generator Windings."

Based on the results achieved on the 60,000-kw generator to which supercharging was first applied, and which has been in commercial service for six months, Mr. Beckwith summarized the benefits as follows:

1. Overall generator weight reduced to 3/4.
2. Active material weight reduced to 60 per cent.
3. Generator length, bearing size, seal size and coupling size reduced.
4. Improved light load efficiencies.
5. Increased gain from higher gas pressure operation.
6. Reduced differential expansion because of shorter length and less temperature difference between copper and iron.

Mr. Beckwith also urged reconsideration of the use of helium for supercharged cooling of generators, because the smaller dimensions of machines cooled this way eliminate many of the usual objections to helium. From a maintenence standpoint there are a number of advantages to helium cooling. Also, construction of a helium-cooled machine may be simplified by comparison to that when hydrogen cooled.

Looking toward the future, supercharging may be applied to the stator and pressures well in excess of the 30-psig maximum now used may be considered. Larger generator ratings may also be expected.

Messrs. Baudry, Heller and Reamey stated that a substantial improvement in the current-carrying capacity of turbine-generator rotors is made possible by circulating the cooling medium directly in contact with the copper conductors. The present limitation arises from the maximum permissible operating temperature of the electrical insulation and the ability to dissipate the heat loss generated within the coils.

The authors described an inner-cooled type of rotor core in which the conductors are drawn in the shape of channel sections and placed together to form rectangular ducts for the passage of the cooling gas. Two conductors form a parallel turn so that no insulation is required between the legs of the channels. The insulation between successive turns is confined by the channel backs where it is entirely removed from the ventilation passages. Construction of a similar type was described for cooling the stator coil.

The proposed combination of inner-cooled rotor and stator coils does not require major departures in manufacturing or operating practice. It makes possible the manufacture of units having capacities much larger than are presently possible, with essentially the same efficiencies.

Italian Power Stations

"Current Expansion, with ECA Sponsorship, of Italy's Thermoelectric Generating Capacity" was the title of a paper by **Fremont Felix** of the International Gen-

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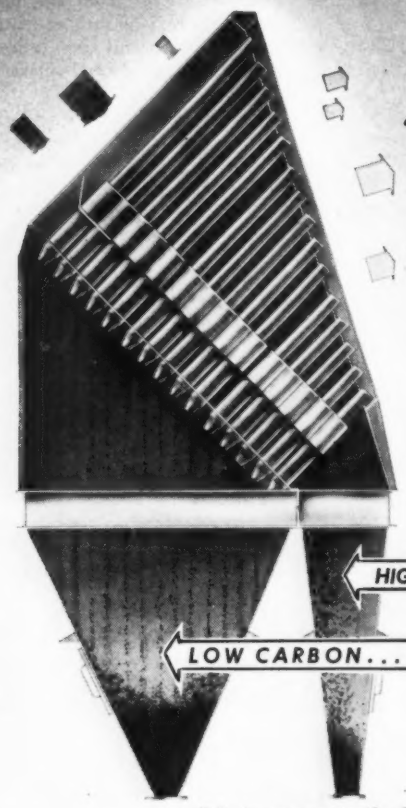

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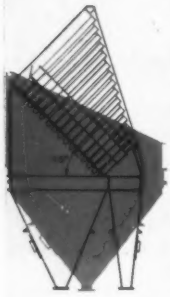

Fly-ash from spreader stoker-fired units, consisting of up to 40% high carbon particles, can effect considerable savings when re-injected. It is necessary to effect separation, however, since the non-combustible smaller particles remaining in the system increase in concentration, causing erosion and possible poor combustion due to spotting.

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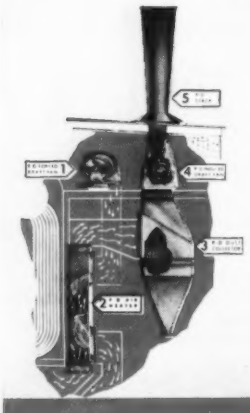

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eral Electric Company. Hydro power has always predominated in Italy, but in 1949–1950 the combination of poor run-off conditions and the lack of capacity from stations devastated during World War II led to a considerable shortage of available electric power. This spurred the allocation of Marshall Plan funds toward bringing steam and hydro power into better balance and at the same time overcoming the power shortage in the most prompt manner possible.

The ECA program for the years 1948–1951 includes a total rating of 720,000 kw and grants in excess of $60,000,000. Not only is this program intended to assist Italy to carry out its role in European recovery, but it is also expected to help boost the electrical energy availability in the less developed parts of that country.

Steam conditions for the stations being built are fairly well standardized, most of them being for 850 psig, 900 F or 1450 psig, 1000/1000 F. The principal fuels to be burned are natural gas and Sardinian coal, but provision will be made in most plants to burn oil.

Italian participation in the way of civil plant construction, transformers and other items supplied locally is about equal to the American contribution, so that the ECA aid may be considered to have an amplification factor of two to one.

Station Performance Calculations

Three engineers from the Consolidated Edison Company of New York, Inc., **E. Daniele, L. J. Parsons** and **G. R. Baiter,** presented a paper entitled "Calculating Machine Simplifies Power Plant Performance Calculations." In large electric utility systems the problem of deciding which units should be operated and how they should be loaded becomes a complex one. Each boiler has a different efficiency characteristic which is dependent upon its design and the type of fuel being burned. Likewise, there are individual performance characteristics of turbines and other factors such as cooling-water temperatures, cleanliness of heat-transfer equipment, variation in fuel prices, and range of load demands must be taken into consideration. A single station consisting of 20 boilers of five different designs supplying steam to any combination of five turbines would have over 15,000 station performance combinations.

To take into consideration even the most commonly encountered combinations would require an enormous amount of time using conventional methods of calculation. Accordingly, an investigation was undertaken to determine whether an IBM tabulating machine could be utilized to establish performance data for economy operation of steam-electric plants. The data required include efficiency of output and incremental rates expressed as functions of outputs.

Several years ago the authors' company developed a mechanical incremental computer which reduces the number of computations necessary to establish station incremental rates. However, its operation is manual and lacks the advantages of a precision calculating machine. It was found that the tabulating machine, operating in a sequence outlined in the paper, re-

quired eight machine-hours for the calculation of ten performance combinations of boilers and turbines as compared to 16 man-hours for the mechanical computer and 30 man-hours using conventional methods. Other advantages are that necessary information is obtained with less effort, errors of calculation are reduced, revised calculations are readily obtained to conform with performance characteristics of specific equipment, and performance of a greater number of combinations may be calculated than could be justified with older methods.

Pipeline Pumping

In a paper on "Automatic Control of Gas Turbines for Natural Gas Pipeline Pumping" **C. R. Ingemanson, A. Loft** and **H. J. Wilt** of the General Electric Company described automatic control equipment for a 5000-hp gas turbine. Since pumping stations are often located in isolated areas, control equipment must be arranged so that the gas turbine can be controlled with a minimum of operating personnel. Provision must be made for starting, loading and stopping the pumping equipment in the shortest possible time with the least number of manual operations. Essentially the control equipment for a pumping unit consists of three components: (1) the main control equipment, (2) the mechanical, electrical and hydraulic control elements of the turbine, and (3) the low-voltage controls for the station and turbine auxiliaries. The control circuits are arranged so that the starting signal will initiate the starting sequence of the gas turbine pumping equipment only when all pre-starting conditions have been satisfied.

C. B. Lester of Mid-Valley Pipeline Company stated that the ideal control system for an oil-line pumping station should meet the following qualifications:

1. Put the station on stream as quickly as possible.
2. Keep the station on stream at the highest efficiency throughout a wide range of flow.
3. Prevent the station's actions from damaging the station, the line of the operating personnel.
4. Be consistent with the economics involved in the problem.

Heat Pump Experience

Results of a two-year experiment on heating and cooling two Philadelphia homes by means of electrically operated pumps using earth as a heat source were reported in three papers by **J. H. Harlow, G. E. Klapper, A. H. Kidder, J. H. Neher** and **Constantine Bary** of the Philadelphia Electric Co.

1. The two installations effectively provided year-round air comfort in the home. Making allowance for their experimental nature, the occupants were satisfied with the heating and cooling effects.
2. The earth provided a reliable heat source and heat sink, including periods of highest heating and cooling requirements, over a two-year period. The heat withdrawn is completely restored by the end of an annual cycle.
3. Use of a low cost material to store heat may allow a reduction in the size of heat pump and improve annual load factor.

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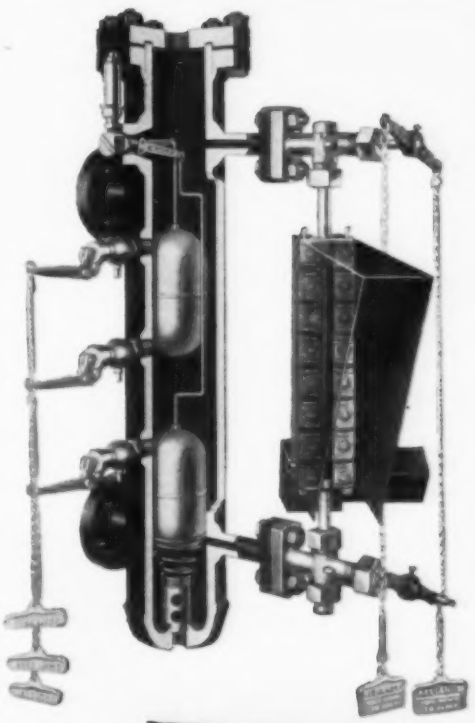

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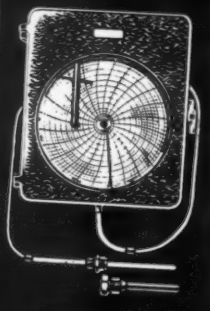

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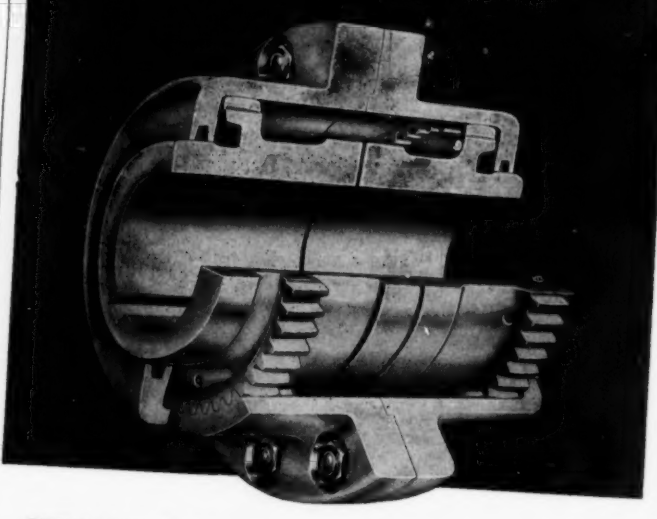

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Natural Gas History

Insight into the history of natural gas was afforded by an address of **Norris C. McGowen**, president of the United Gas Corporation, at a testimonial dinner given by the American Newcomen Society at New Orleans, December 13, 1951.

The ancients many centuries ago, said Mr. McGowen, worshipped fires burning from fissures in the ground, but it was the Chinese who first put the gas to practical use by piping it through bamboo pipes to evaporate brine from salt wells.

Its existence was noted in England about the middle of the Seventeenth Century, as mentioned in the records of the Royal Philosophical Society of London, and again in West Virginia in 1775, the latter being the first recorded reference to natural gas in the United States. Later it was found in other areas in this country when drilling for well water; but its possibilities were not recognized until 1821 when the first gas well was dug at Fredonia, N. Y., and the gas later piped for local lighting. The Fredonia Gas Light and Water Works, formed around 1825, was the first natural gas company in the world.

In the interim, from 1785 through 1798, William Murdock in England had initiated and made considerable progress in the making of gas from coal, which he applied to lighting the Soho Works of James Watt. Subsequently, in 1812 the world's first gas company, utilizing manufactured gas, was chartered in London, and it was in 1816 that the city of Baltimore contracted for gas lighting of its streets.

First Gas Transmission Line

For the ensuing 25 or 30 years natural gas was discovered in various sections of this country and applied locally, but the first successful natural gas transmission line was a 2-in. iron pipe line laid from the Newton fields to Titusville, Pa., in 1872. This followed shortly after an unsuccessful attempt at Rochester, N. Y., to transmit gas through a wooden pipe line consisting of drilled-cut logs with bell-type joints having hot pitch seals, which was found to leak badly.

However, widespread use of natural gas in the United States began when compressors were designed for pipe-line transmission.

Large discoveries of natural gas were made in Kansas in 1882 but it was not until 1904 that the first major pipe-line company was organized to carry gas from the Kansas fields to industrial centers in Kansas and Missouri.

Natural gas was discovered in Texas in 1871 and about the same time in Louisiana, followed by outputs concurrent with oil prospecting in those areas which began to assume large proportions about the beginning of the Twentieth Century. At first, sales of the gas were confined to nearby communities, but such sales failed to provide an outlet for much of the gas available. This gave rise to various oil and gas companies and distribution systems which later combined into major groups.

In 1930, with five major groups as a nucleus, more than forty associated companies were welded into the United Gas Corporation with approximately 5700 miles of transmission, distribution and field pipe lines. Today United Gas supplies at retail approximately 400,000 consumers through 9597 miles of distribution and services lines in 291 cities and towns. Served by this system are large portions of Texas, Louisiana and Mississippi, with extensions to Mobile and Pensacola.

Gas-engine Power for Aluminum

Shown in the accompanying photo are forty of the eighty Nordberg gas-burning radial engines which supply approximately 150,000 hp for the first two potlines to go into production at the Chalmette, La., alumina reduction plant of Kaiser Aluminum and Chemical Corp. This plant will ultimately contain eight potlines capable of converting alumina to metallic aluminum at the rate of 46,000 lb per hr around the clock.

The radial engines are of the two-cycle type with 11 cylinders of 14-in. bore and 16-in. stroke. Each develops 1820 hp at 400 rpm and drives a direct-connected G-E 1290-kw d-c generator. Cylinders are equally spaced in a horizontal plane around a vertical shaft and fire in consecutive order. Each engine-generator unit has its own control cubicle, including protection equipment to shut off the engine automatically.

Electricity for the remaining six potlines and for plant services will be produced in a semi-outdoor type steam power plant made up of 15 steam generators and 16 turbo-generators. A rectifier station will be installed to convert a-c generated in the steam plant to d-c for use in the electrolytic cells.

First Commercial Coal to High-Octane Gasoline Plant

The first commercial installation for making high-octane gasoline from coal is to be built near Johannesburg, S. A., for the South African Coal, Oil and Gas Corp. Ltd. (SASOL). The project is an international undertaking to an unusual degree. The M. W. Kellogg Company, New York, will be responsible for the overall design and engineering of process facilities, although part of the engineering and of the manufacturing of process facilities will be handled by German firms and the engineering of power facilities has been assigned to a Belgian firm. Combustion Engineering-Superheater, Inc., as the prime contractor for the boilers, will sublet some of the manufacturing to affiliated companies in France and South Africa. This distribution of the work will not only expedite construction, but will help to meet problems of dollar exchange and material shortages.

Large Boiler Plant Involved

Each of the four boilers will be capable of producing 370,000 lb of steam per hour at 700 psig, 800 F, and will burn South African coal in pulverized form. This coal, as received, runs about 30 per cent ash and 25 per cent volatile, with a heating value of about 13,000 Btu per lb and six per cent moisture.

It may be mentioned that, although the U. S. Bureau of Mines has constructed a pilot plant in this country for producing gasoline from coal, no such commercial plants have been built. Those built and operated in Germany during the war utilized an earlier process and were not capable of producing the high-octane gasoline such as is expected to be produced when the new Johannesburg plant gets into operation.

Gas engines at Kaiser aluminum plant

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1 . . . Compactness Note in the picture above the short axial length. Tubes 3" in size and larger are approximately 1 to 1½ diameters long, depending upon the velocity in the main. For high main line velocities (above 10 ft/sec. for liquids) tubes are less than 1 diameter in length.

2 . . . Ease of Installation Due to its compactness and because it requires no straight runs upstream or downstream, except near valves or regulators, the total space required for installation is but a small fraction of that necessary for other primary devices. It can be installed as readily as a fitting and in that section of the line most conducive to steady flow conditions. Moreover, it can be installed in the plant proper, eliminating the need for expensive vaults or housing.

3 . . . Reversibility The Foster Flow Tube is symmetrical transversely; upstream and downstream nozzles and ports are identical. This means that where processing calls for flow reversal, the meter can readily handle the changes.

4 . . . Low Head Loss Where head losses are important Foster Flow Tubes are designed with a main-to-throat ratio that provides negligible unrecovered head losses.

5 . . . Accuracy All Foster Flow Tubes are furnished with calibration curves obtained in laboratory tests simulating installation conditions and can therefore be guaranteed to an accuracy to meet *any* specification.

Foster Flow Tubes are recommended for a wide range of services metering the flow of liquids and wet or dry gases. They are available in all commercial pipe sizes with flanged or screwed connections. Standard lining is bronze but other materials are available. In writing for further information, give processing and installation details of your metering requirements.

FOSTER ENGINEERING

New Catalogs and Bulletins

Any of these may be secured by writing Combustion Publishing Company, 200 Madison Avenue, New York, 16, N. Y.

Communication Systems

An attractive 20-page brochure on power plant communication systems has been prepared by Gai-Tronics Corp. It explains what the communication system is, what it will do, how it operates, what it consists of and what it costs. Interior views of central stations show the locations of communication equipment, and there are also photos of component parts.

Testing Equipment

An 80-page catalog summarizing testing and measuring equipment for laboratory production line use has been made available by the General Electric Co. Designated as GEC-1016, the catalog contains more than 150 photographs and diagrams and describes the uses, features, specification and prices of more than 130 testing and measuring devices.

Ion-Exchange Materials

Bulletin 59 issued by the National Aluminate Corp. describes physical properties, expansion data, and regeneration and capacity of Super Nalcolite. The six-page bulletin also contains tables and a graph pertaining to the same material.

Regulating Valves

Bulletin 700 issued by Spence Engineering Co. features a large cutaway illustration of a typical pilot-operated regulating valve with explanations of five design features. There is also a discussion in the four-page bulletin of the manner in which the control function of the regulator can be changed by using a different sensitive pilot.

Pump Instructions

A 30-page instruction booklet, No. 08X7613, covering the installation, operation and repair of single-stage, double-suction centrifugal pumps has been released by the Allis-Chalmers Manufacturing Co. One page of the booklet is for use as a permanent record of the operator's pump and of its performance. It also carries a quick reference guide which lists 40 possible causes of trouble in pump operation and their cures.

Packings and Gaskets

Johns-Manville has issued a six-page folder entitled "Packings for the Power Plant." This quick reference aid features a flow sheet of a rudimentary industrial power plant with each unit keyed to the proper packings and gaskets. These are illustrated by photographs and include construction information and sizes. The

packings and gaskets are also grouped according to the applications and services for which they are recommended.

Synchronous Motors

Publication No. 1200-TEC-1111 of the Electric Machinery Mg. Co. is a reprint of a paper entitled "Application of Direct-Connected Synchronous Motors to Reciprocating Compressors" by G. L. Oscarson. This paper is attractively illustrated and contains several diagrams which effectively show current variations in synchronous motors. The discussion deals largely with consideration of proper rotor flywheel effect as a preventive measure for voltage fluctuations when driving compressors by these motors. Formulas, sample calculations and reference curves are included.

Chemists to Hold Air Pollution Conference

The Manufacturing Chemists' Association (a national organization with headquarters in Washington, D. C.) is sponsoring a conference on the exchange of technical information relating to air pollution abatement, to be held at the Hotel Statler, New York, February 25 and 26. The following program has been announced:

February 25, 10 a.m.

"Review and Survey of Air Pollution Abatement by the Chemical Industry," by James M. Gillet of MCA.

"A Rational Approach to Air Pollution Legislation," by George Best of MCA Legislative Committee.

12:30 p.m.—Luncheon.

2 p.m.

"The New Jersey Problem," by Dr. R. H. Daines and Dr. D. S. Bergsma.

"Some Experiences with Air Pollution Abatement in the Steel Industry," by Dr. C. A. Bishop, U. S. Steel Corp.

"Atmospheric Contamination and Health," by Dr. John Foulger, E. I. du Pont de Nemours & Company.

6 p.m.

Dinner addressed by Dr. H. G. Dyktor, Commissioner of Air Pollution Control, Cleveland, Ohio.

February 26, 9:30 a.m.

"Planning Avoids Air Pollution," by C. A. Gosline of E. I. du Pont de Nemours & Company.

"Wind Tunnel Techniques Used to Study Influence of Building Configuration on Stack Gas Dispersal," by W. T. Ingram, New York University.

"Anticipating and Preparing Against Possible Industrial Hazards from Air Pollution," by Dr. G. R. Hill, American Smelting and Refining Company.

"Area Pollution Problems and the Individual Plant," by Dr. H. P. Munger, Battelle Memorial Institute.

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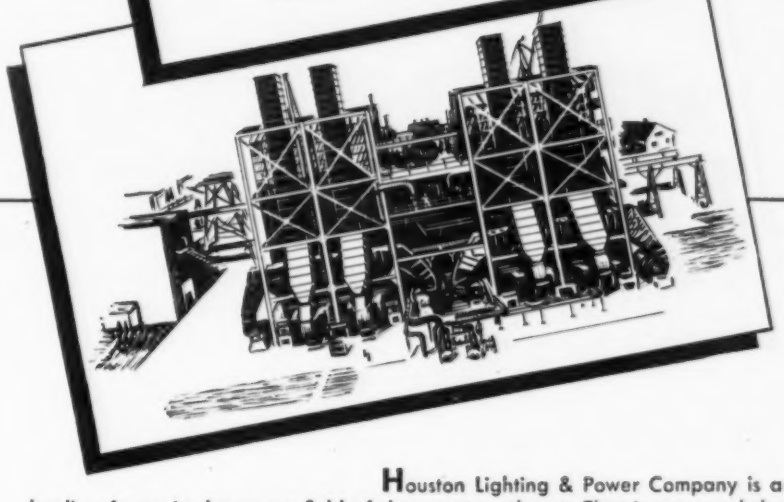

Houston Lighting & Power Company is a leading factor in the power field of the great southwest. That it approved the selection of Green Draft Fans by the boiler manufacturer — in this case Riley Stoker — is evidence of high acceptance in the field. No utility can afford to operate with inferior or unsuitable equipment at any point. It must have equipment that is not only highly efficient but right.

To Houston Lighting & Power can be added other well-known recently completed utilities that are Green Fan plants, among them the following:

Central Hudson Gas & Electric Co.
Atlantic City Electric Co.
Virginia Electric & Power Co.
Monongahela Power Co.
Louisiana Power Light Co.
Kansas Gas & Electric Co.
El Paso Natural Gas Co.
Pacific Gas & Electric Co.
South Carolina Public Service Authority
Buffalo Niagara Electric Corp.

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BETWEEN TWO FIRES

Boiler steel meets "fire" on *both* sides of tubes and drums. Just as flame, in consuming fuel, tends directly or indirectly to cause deterioration of fire-side boiler steel, so water, too, reacts with metal — less obviously, perhaps, but nonetheless surely — for water is and always will remain a chemical, potentially destructive to steel.

Recognizing this fact, operators of boilers large and small — in central stations, industrial plants, aboard ship and on the railroads — apply a protective coating of Apexior Number 1 to all steam and boiler-water-exposed metal.

Apexior helps retain for the life of any boiler the advantages of new or newly cleaned metal. It grips steel with a hold never released in normal boiler operation. Impervious to moisture, it ends water-metal contact — repels deposits, too, by adding a surface so smooth it denies them a footing.

Thus Apexiorized metal remains sound — stays in service longer. Free from heat-transfer barriers, it puts b.t.u.'s to work more efficiently. In a word, *better* boiler performance — and more of it — is the return Apexior gives you on a truly modest investment.

MAINTENANCE FOR METAL

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Personals

Guy W. Thaxton has been appointed power engineer in the Division of Construction and Supply of the U. S. Atomic Energy Commission. He was formerly regional power supply coordinator of the Defense Electric Power Administration.

Walter Baggaley, for a number of years associated with the Austin Company, engineers and builders, and for the past three years a project engineer on atomic energy plants, has resigned to join the faculty of the American University of Beirut (Lebanon) as professor and head of the Mechanical Engineering Department.

Cecil Schwartz, stress analyst for Barnes & Reineke, Inc., Chicago, has been named associate engineer in the Heat-Power Research Department at the Armour Research Foundation of Illinois Institute of Technology.

George H. Woodard has returned to Houston, Tex., as manager of Republic Flow Meters new office at 2426 W. Holcombe Blvd., Houston, after a number of years as power plant design and construction engineer with a firm of consulting engineers and as project engineer at Republic's factory.

Edward H. Barry, until lately mechanical engineer with Stone & Webster Engineering Corp., has become associated with The Pierce Consulting Engineering Company, 183 Essex Street, Boston, Mass.

A. C. Pasini has been made Superintendent of The Detroit Edison Company's new St. Clair Power Plant.

Hans P. Dahlstrand, well-known steam turbine designer, retired on January first as director of steam turbine engineering at Allis-Chalmers Mfg. Co. after 47 yr of service with that firm.

Henry N. Shoiket has been made head of the Mechanical Engineering Department of Sam Tour & Co., specialists in research and development in non-destructive testing.

Dr. John T. Rettaliata, vice president and dean of engineering at Illinois Institute of Technology, has been named president of that institution.

Frank N. Kemmer, formerly manager of chemical research for Cochrane Corp., has joined the National Aluminate Corp., Chicago, as chemical engineer. However, he will make his headquarters in the vicinity of Philadelphia.

James R. Largay has been named Superintendent of the Niagara Mohawk Power Corporation's Albany steam station. He has been serving as superintendent of that company's Amsterdam station.

William J. Clapp has recently been elected president of the Florida Power Corp., succeeding W. C. Gilman who became chairman of the Executive Committee. Mr. Clapp joined the Company in 1925 upon graduation in electrical engineering from Clemson College.